PB82-134768

The Role of Conservation Districts and the Agricultural Community in Wastewater Land Treatment

(U.S.) Environmental Protection Agency
Washington, DC

Sep 81

U.S. Department of Commerce
National Technical Information Service
NTIS.

United States
Environmental Protection
Agency

Office of Water
Program Operations (WH-547)
Washington, D.C. 20460

September 1981
430/9-81-019

PB82-134768

EPA

The Role of Conservation Districts and the Agricultural Community in Wastewater Land Treatment

Final Report

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NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

MCD-82

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. MCD-82	2.
3. RECIPIENT'S ACCESSION NO. PB82 134768	
4. TITLE AND SUBTITLE The Role of Conservation Districts and the Agricultural Community in Wastewater Land Treatment	5. REPORT DATE September 1981
	6. PERFORMING ORGANIZATION CODE 2341004
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO. 430/9-81-019
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO. 2BC 647
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Water Program Operations U.S. Environmental Protection Agency Washington, D.C. 20460	13. TYPE OF REPORT AND PERIOD COVERED Technical Report
	14. SPONSORING AGENCY CODE 700/02

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This booklet is intended to help municipal officials, on the one hand, and conservation districts, local landowners and the agricultural community recognize the opportunities for coordinated action on wastewater management. Subsequent sections of the report provide basic information about different land treatment technologies, with the most attention given to wastewater irrigation-the approach with most direct relevence to agriculture. Brief case histories of cooperative efforts between landowners and municipalities are provided, many of them involving the active participation of a local conservation district. The concluding sections describe recent federal incentives for wastewater land treatment, and the potential roles that soil and water conservation districts could play in assisting communities and landowners.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Water Pollution Control	Wastewater Land Treatment	

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)* non-sensitive	21. NO. OF PAGES 21
	20. SECURITY CLASS *(This page)* non-sensitive	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

The Role of Conservation Districts and the Agricultural Community in Wastewater Land Treatment

Final Report
December 11, 1980

Prepared by the National Association of Conservation Districts

December 11, 1980

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Foreword

This paper has been prepared by the staff of the National Association of Conservation Districts as a contribution toward clarifying the potential role of conservation districts in sewage wastewater application to land. We are indebted to the many people who assisted in its writing and review.

The initial data and materials for the study were assembled, and the paper was written by Wendell Fletcher.

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These people all contributed to the amount and quality of the material in the paper, but NACAD is responsible for the conclusions reached and for any errors that may become evident.

Neil Sampson
Executive Vice President

Introduction

For many communities around the country, disposing of municipal wastewater has proven to be an expensive and difficult task. The costs of building and operating conventional sewage treatment plants are escalating. At the same time, Federal and State clean water standards are becoming more stringent, requiring communities to provide more advanced levels of wastewater treatment than previously. As a result, communities are looking for alternative ways to do the job.

One of the most promising alternatives is wastewater land treatment.* By applying the wastewater to the land, rather than discharging it into a river or other water body as is the case with conventional treatment systems, land treatment utilizes the restorative capacities of soil and plants to cleanse the water, and to recycle wastewater nutrients that would otherwise be a cause of water pollution.

As a result, land treatment not only cleans up the water but also can help to achieve other objectives besides wastewater treatment. Many farmers around the country are irrigating crops safely and effectively with wastewater. Some communities use land treatment to replenish groundwater. Others water golf courses and parkland with wastewater. The key concept involved is reuse of resources that would otherwise be discharged into water bodies.

Although simple in concept, land treatment requires the active involvement of a variety of professions not normally associated with sewage treatment.

Farmers, conservationists, agronomists, foresters, soil and water resource specialists—all have a role to play in identifying the most appropriate resource recycling objectives of land treatment, and in the design and actual implementation of a land treatment program. Close coordination and communication between these resource managers or users and water pollution control specialists is thus essential.

How can this be achieved? The answer will vary in each community, but, in many areas, local soil and water conservation districts can play an invaluable role. For over 40 years, these local units of State government have been working with land owners or users and other government agencies to achieve a variety of resource management objectives on both private and public land. As many communities have already discovered, the local district is often ideally situated to assist both landowners and municipalities in assessing the potential of wastewater land treatment.

This booklet is intended to help municipal officials, on the one hand, and conservation districts, local landowners and the agricultural community recognize the opportunities for coordinated action on wastewater management. Subsequent sections of the report provide basic information about different land treatment technologies, with the most attention given to wastewater irrigation—the approach with most direct relevence to agriculture. Brief case histories of cooperative efforts between landowners and municipalities are provided, many of them involving the active participation of a local conservation district. The concluding sections describe recent federal incentives for wastewater land treatment, and the potential roles that soil and water conservation districts could play in assisting communities and landowners.

*Wastewater land treatment should not be confused with the term conservation land treatment, which refers to the installation of soil and water conservation practices.

Why the Interest in Land Treatment?

Land treatment is nothing new. The Romans (and several other ancient cultures) used running water to collect human wastes, and sometimes applied this wastewater to the land. For much of the nineteenth Century in England, land treatment was considered the only safe and reliable way to dispose of wastes from newly developed sewer systems. Several other European cities (such as Berlin and Paris) relied on land treatment during the mid-1800's. Melbourne, Australia, has used land treatment since the turn of the century. In many European areas, however, land treatment systems were phased out and replaced with what are today called conventional sewage treatment plants. As city populations grew, competition for land and other factors favored selection of conventional plants.

Although a few communities in this country have been operating land treatment systems since the late Nineteenth Century, most favored other means of treatment that could cheaply reduce health hazards in municipal wastes. Thus, it was not until recently—when water pollution control became a major objective—that land treatment began to be revived as an alternative to conventional treatment. The major reasons for this renaissance are:

More stringent federal and state water pollution control requirements. To meet these requirements, many communities are now upgrading existing sewage treatment facilities to provide more advanced treatment, or are building new plants for the first time. Although land treatment is more expensive than primary treatment (see box on page 2), it is often more cost-effective than conventional treatment systems. Moreover, when properly done, land treatment often is the most effective way to cleanse wastewater.

Recent federal legislation requires the U.S. Environmental Protection Agency (EPA) to be sure that communities have fully studied land treatment (or other innovative, alternative techniques) before making grants for construction of new or expanded facilities. Communities that do use such techniques receive more favorable grant conditions.

Interest in Reuse of Resources. The secondary benefits of land treatment are now receiving greater attention. Resource constraints—limited water supplies in the West, ever higher energy prices, escalating fertilizer prices— have made recycling and reuse of wastewater an attractive option. Moreover, economic changes have made it more feasible for both municipalities and landowners to utilize wastewater as a re-

Irrigation with Wastewater

source rather than simply disposing of it. In addition to recycling nutrients and water, land treatment generally involves less expenditure of energy than other advanced systems of wastewater treatment.

Fewer Health or Environmental Problems than Most Other Systems. Research is showing that fears about health hazards and contamination of the soil and groundwater from land treatment are mostly unfounded. Land treatment is not risk free; without careful site selection, monitoring, and prompt corrective action when called for, contamination of the soil or land is possible. But, a well designed and operated land treatment systems not only is safe, but poses less environmental risk than most conventional treatment systems.

While land treatment is increasingly used, its full promise has yet to be realized. One official of the U.S. Environmental Protection Agency, the Federal agency most involved in land treatment, has noted: "Overly restrictive state regulations, resistance by the consultants and engineers trained or experienced only in traditional sanitary engineering techniques, public acceptance issues and public health concerns remain (more of) a problem in the implementation of new projects than our ability to properly design and operate cost-effective and environmentally sound land treatment systems."

Several different methods of wastewater land treatment exist, but irrigation of crops, grasses or forests with wastewater is the most common method, and the one with the greatest relevance to agriculture. With limited water supplies in the West, and rising costs and uncertain availability of fertilizer everywhere, wastewater irrigation is becoming an increasingly attractive option for communities and farms.

Called slow-rate infiltration by water pollution specialists, wastewater irrigation is used in over 500 communities around the country, and another 600 communities are in the process of developing a program. In addition, many companies that produce organic wastes (such as canneries) use wastewater irrigation.

The details of the technique vary from place to place, but all rely upon the capabilities of soil and plants to renovate the wastewater. After pretreatment (see box below), the wastewater is sprayed or flooded on a carefully selected site, which has the proper vegetation, soil, topographic and hydrologic conditions to filter the wastes. The plants remove nutrients (such as phosphorous and nitrogen) from the wastewater, and use them for their own growth. Much of the water is also consumed by the plants through evapotranspiration or storage in plant tissues.

Some wastewater may filter through to the groundwater or runoff to streams, but water pollution is usually less of a problem than with conventional treatment systems which discharge effluents directly into water bodies. In some areas, however, underdrains, wells or collection ditches may be needed to recapture the water and recycle it after it has been applied to the land.

Done properly, wastewater irrigation is one of the most effective water pollution control techniques. It is often a less costly option than other techniques for meeting water quality requirements, and is still highly effective in reducing pollution. Moreover, it can be used to further a number of other community objectives. These include:

Crop Production. Many communities are offsetting the costs of wastewater treatment through crop irrigation. In areas where irrigation water is valuable, communties can often avoid the high costs of acquiring land for wastewater irrigation by contracting with local farmers to take the wastewater for their own fields. This usually benefits both the farmer, who receives an assured supply of irrigation water, and the community, which not only avoids land acquisition costs, but also cuts down operating expenses. Other communities grow crops for sale on municipal land. Irrigation of forest land with wastewater can also provide an economic return, although generally more modest than for field crop production.

Wastewater is both a source of water and nutrients for plants. Although efficient irrigation often requires addition of supplemental nutrients, high crop yields can frequently be achieved. Doubling or tripling of corn yields in comparision with equivalent, non-irrigated acreage have been recorded, and high levels of production of forage grasses, soybeans, cotton, alfalfa and other crops without use of commercial fertilizer are common. Done properly, wastewater irrigation can also improve soil conditions through return of organic matter to the soil structure.

Water Conservation and Reuse. In the West, where water is scarce, wastewater irrigation can help achieve water conservation objectives. The key is reuse of water that otherwise would be used only once. This can reduce the intense competition for water that exists between irrigation agriculture and urban uses. Many western communities have worked out innovative agreements with local farmers to help meet urban and agriculture water demands.

Water conservation objectives are not limited to the West: many eastern areas face shortages of good quality water for domestic use because of pollution of surface water and groundwater supplies. Some areas face limitations on new

How Land Treatment Differs from Conventional Wastewater Treatment

Conventional wastewater treatment discharges treated effluent into a stream or water body. In most communities, treatment consists of two stages:

- Physical ("primary") treatment. This stage screens off wood, oil, paper and other floating materials in the sewage, and allows solids to settle to the bottom of a holding tank as raw sludge. In the past, when pollution control objectives were less stringent, many communities ended wastewater treatment at this stage. The wastewater was simply discharged into a stream with no further treament. The sludge was disposed of separately.

- Biological ("secondary") treatment. This is the second stage in conventional treatment. It relies on ability of bacteria to break down organic matter in the wastewater, which is filtered over bacteria covered rocks, or exposed to biologically active sludge. The wastewater is then discharged into the water. Biological treatment reduces organic matter in the wastewater, but only partially removes nutrients (like nitrogen and phosphorous) and other wastes. Thus, water pollution remains a problem.

Many communities stop treatment at the biological treatment stage. But a variety of other processes have been developed that provide additional purification of the effluent. The most commonly used process is disinfection with chlorine to reduce bacterial contamination of surface waters. Other techniques, such as coagulation-sedimentation, adsorption, and electrodialysis, follow biological treatment and are therefore sometimes called tertiary treatment. They are highly effective, but also very expensive, and tend to be energy intensive.

Land treatment is also considered an advanced technology. Typically the sewage is partially treated in a treatment pond before it is applied to land. The ponds can be used not only as part of the treatment process but also to hold the wastewater until conditions are right to apply it to the land. Additional reservoirs may be needed to store the wastewater—especially where winter conditions do not permit application. Depending upon the likelihood of public exposure to the wastewater, the amount of pretreatment required varies. Control of pathogen is achieved by temporary storage or by chlorination.

What Other Land Treatment Techniques Are Used

Rapid-Infiltration. This technique allows recovery of renovated wastewater or groundwater recharge. The wastewater is spread in basins overlying highly permeable soils (sand or loamy sands). The soil serves as a filter which removes suspended solids and some other wastewater constitutents. Percolating rapidly through the soil, much of the water eventually reaches the groundwater, where it can be recovered through wells or underdrains, or left to recharge the acquifier. The recovered water can be used for crop irrigation, or industrial uses. If left in the ground, the water can help maintain groundwater levels, and, in some coastal areas, protect against salt water intrusion. Because rapid-infiltration does not generally employ vegetation to remove nutrients, careful management and monitoring is needed to ensure against nitrate contamination of the groundwater In high concentrations, nitrates are toxic.

Overland Flow. Under this method, the wastewater is sprayed on the upper reaches of vegetated, slowly permeable soil. The water is renovated by the action of the soil and vegetation as it descends in a thin film down the slope, and is collected in ditches near the bottom for either discharge into a stream or reuse. This method results in a high level of nitrogen and biochemical oxygen demand (BOD) removal, both of which affect water quality. Thus, eventual discharge into the stream is not considered a major problem. Because of soil impermeability, little or no effluent reaches the groundwater.

Vegetation (usually water-tolerant grass species) is an essential component of this approach—both in terms of preventing erosion of the slope and removing nutrients. The grass can be harvested as a forage crop. With careful management, overland flow can be used on slopes that might otherwise be marginal for crop production, but should not be used on slopes with a grade over 6 percent. Site preparation costs can be high because of the need to construct terraces or drainage systems. If applied under freezing weather conditions, the wastewater may run off frozen slopes without renovation or purification. Therefore, storage lagoons may be necessary.

Several other kinds of land treatment approaches are currently being studied. Wetlands—marshes, bogs, peatlands, and swamps—are considered particularly promising, because of their abilities to reduce BOD and remove suspended solids and nutrients. In areas with adverse soil conditions, subsurface filters or soil mounds may also be used.

Question and Answers about Wastewater Irrigation

Each community that is considering wastewater irrigation (or other land treatment approaches) needs to ask and answer for itself a number of questions about the technique. Wastewater irrigation is a proven treatment approach that is used in many parts of the world. But it is not necessarily the right solution to every community's wastewater treatment problem. Moreover, land treatment systems need to be carefully designed to meet both water pollution control objectives and agricultural or other land use and water resource objectives.

Adapting land treatment to the individual needs of the community requires a great deal of involvement from diverse groups. Because the situation in each community is different, no two communities will come up with exactly the same program. But most share common concerns:

Is Wastewater Irrigation Cost Effective?

The answer will depend upon the circumstances in each community, but in general, wastewater irrigation compares favorably in cost with most other advanced treatment systems.

In most areas, the primary cost of a wastewater irrigation system is likely to be land. Wastewater irrigation requires more land than all other means of wastewater treatment, including other methods of land treatment. In urban areas, especially, it may be difficult to assemble large enough quantities of land at affordable cost for wastewater irrigation. Land availability can also be a problem. It is cheapest to irrigate with wastewater in close proximity to the collection and storage facilities, but this may not always be possible. Thus, transmission facilities may need to be installed. Pretreatment and storage facilities are also needed, as well as irrigation equipment, and where necessary, underdrains, catchments and other drainage facilities.

While land costs can be high, operation and maintenance costs are generally much lower than is the case with other advanced systems, or conventional treatment. In many areas, operation and maintenance costs can be off-set even further through economic returns from crop production.

Because of the funding provisions of recent Federal legislation, the distinction between capital costs and operation and maintenance costs is especially important. The 1977 Clean Water Act authorizes Federal grants covering 85 percent of the capital costs of

growth because of inadequate sewage treatment systems. In circumstances where conventional treatment and discharge is not adequate to protect water quality, wastewater irrigation may be the best solution.

Enhancement of Recreational Values. Wastewater irrigation also has been used to achieve recreation or amenity objectives. These may not always provide a direct economic return, but can help achieve desirable social and environmental goals. Some communities treat greenbelts and parkland with wastewater. Over 70 communities around the country water golf courses with it. Wastewater can also be applied to lawns, highway median strips, and other "amenity" lands. These uses generally result in greater public exposure to wastewater, and therefore, more stringent pretreatment is usually required before the land is treated with the effluent than is the case with many crop uses.

Enhancement of water recreation and fishing is sometimes an indirect benefit of wastewater irrigation. Water recreation opportunities in many areas have been diminished because of discharge of municipal effluents. Even with conventional biological treatment, enough nutrients are discharged into the water to cause excessive plant and algae growth in many areas. This can force changes in fish species, and make the water less appealing for recreation. Because land treatment virtually eliminates discharge into the water, improved water quality—often at less expense than other advanced treatment systems—results. Communities such as Muskegon, Michigan; Greenville, Maine; and El Reno, Oklahoma have discovered the water recreation benefits of land treatment.

Other Benefits. Land treatment can also be used to help in the reclamation of surface mined land, restore marginal land to productive use, and achieve community growth management objectives. It can also help achieve energy conservation objectives: compared to other advanced treatment systems, it generally requires far less energy to operate.

Because there are many potential uses for wastewater irrigation, defining community goals and objectives is important. In all cases, however, these secondary objectives must be consistent with the primary purpose of wastewater irrigation—preventing water pollution. This requires close coordination between water pollution control specialists and resource managers to assure that all objectives are met.

wastewater irrigation, as well as other innovative or alternative technologies. The grant can be used to acquire land, and in some circumstances, EPA will also pick up 85 percent of the costs of leasing land. Conventional systems are only eligible for 75 percent grants, which cannot be used for land acquisition.

In both conventional and alternative systems, operation and maintenance costs are not covered by the Federal government, and must be fully assumed by local jurisdiction. Thus, when the total costs of different wastewater facilities are about the same, the one with higher capital costs and lower operation/maintenance costs will require the least local expenditure, as is suggested by the following table.

Wastewater Irrigation Versus Conventional Alternatives

Costs per household per month

System	Total	Capital	Operation/ Maintenance	Local Share
Irrigation	$4.20	$3.30	$.90	$1.40
Secondary	5.40	2.50	2.90	3.50
Advanced treatment (with phosphorus and nitrogen removal)	10.20	5.40	4.80	6.40

ADAPTED FROM: Metcalf & Eddy/U.S. EPA

What Kinds of Sites Should be Used?

Selection of a proper site for wastewater irrigation is essential. From a physical perspective, the soil and plant complex of the site must be capable of renovating the wastewater to acceptable standards without causing significant erosion or other environmental problems. The site must also make sense economically: it it is located too far from the pretreatment facilities, the wastewater irrigation system may not be cost effective. Social and political factors also need to be considered, since in some areas, there may be public resistance to wastewater irrigation sites.

Many different factors affect the physical appropriateness of a site—including soils, topography, climatic conditions, and hydrology. The physical characteristics of the site need to be identified in order to determine whether it is capable of handling the desired rate of of wastewater application. This is a matter that requires close coordination among municipal wastewater officials and resource professionals. In many local soil and water conservation districts, Soil Conservation Service, State Extension Service personnel, and other resource and environmental agencies have provided assistance to localities in assessing the adequacy of existing data, and in recommending appropriate sites.

In order to prevent soil erosion and rapid runoff of effluents, wastewater irrigation needs to take place on relatively flat land—generally, on slopes of less than 10 percent if spray irrigation is used, and less than five percent if ridge-and-furrow irrigation is used. Crop irrigation on steeper slopes would usually require construction of terraces, collection of irrigation return flows, or other measures to meet soil conservation and pollution control objectives. Slopes of up to 30 percent can be suitable for wastewater irrigation on forestland.

Soil characteristics and drainage patterns are also key factors in site selection. Wastewater irrigation should generally be conducted on moderately permeable soils. Loamy soils are preferred, but soils ranging from loamy sand to clay loams can sometimes be used. To insure optimal plant growth, renovation of wastewater, and reduce infiltration to groundwater, soil depths of five feet or more are preferred. Underdrains or other measures may be needed if the soil is shallow and no bedrock is present.

Climatic conditions are also important. In cold climate areas, storage reservoirs may be needed to hold the wastewater until conditions are right for irrigation of crop land. Irrigation of perennial grasses and forest land is sometimes done in cold weather, but snow cover and subfreezing conditions can reduce the efficiency of treatment. Where excessive rainfall is a problem, special care must be taken to avoid waterlogging of the soil.

The amount of land needed for wastewater irrigation is highly variable—ranging from 60 to 500 acres for a one million gallon per day facility, with 150 to 250 acres typical. In part, this variation stems from physical differences among sites. But the purposes of the system also play a role. When economic return from crop production is an important factor, the wastewater application rate should not exceed the consumptive capabilities of the crops so much that it reduces yields. This may require relatively more land for the irrigation itself or for storage facilities. Where economic return is not a consideration and where rainfall conditions warrant, it is sometimes possible to increase rates of wastewater application, through use of water tolerant grasses with high nutrient uptake capabilities. This can reduce land needs, but may restrict crop production.

Although wastewater irigation is the most pervasive land treatment technique, it may not be suitable in all areas. Where that is the case, other systems of land treatment (such as rapid infiltration and overland flow) may be appropriate.

Should Public or Private Land be Used?

Land acquisition is sometimes an obstacle for communities trying to start a wastewater irrigation program. This is especially a problem in urban areas, where land costs are very high and the supply of land is limited. To encourage communities to adopt land treatment approaches, the Federal government will pick up 85 percent of the costs of land acquisition when appropriate. But, in some areas, wastewater irrigation will not be cost-effective even when these incentives are factored in.

Fortunately, however, a key advantage of wastewater irrigation is its flexibility. Many communities have worked out agreements with nearby landowners and farmers for utilization of the wastewater, under terms that are mutually advantageous to both. The farmer gets an assured supply of irrigation water, while the community can cut down its costs, and avoid the headache of managing an agricultural operation. Other approaches involve leasing of land, hired managers or sale of forage and crops. (These different approaches are described in the case studies in Chapter 5. Sample agreements between landowners and communities are reproduced in Appendix II.)

There may be reasons why the community wishes to actually own the wastewater irrigation site. Many communities already have parkland or other land in public ownership on which to spray the wastewater; since the land is already owned, this keeps costs at a minimum and may enhance the value of the land. Another is control over the process of wastewater treatment. Communities need assurance that the irrigation site will be available over the lifetime of the system—generally several decades. It may be difficult to convince landowners to agree to such a long term commitment, especially in rapidly growing areas or where irrigation water is not highly valued.

What About Crop Yields?

Wastewater is valuable for irrigation and as a supply of plant nutrients. As a result, irrigation generally results in higher crop yields than non-irrigated farming on equivalent land, and in many areas, compares favorably with other sources of irrigation water since high crop yields can often be achieved with limited amounts of commercial fertilizer.

Municipal wastewater contains useful quantities of phosphorus, nitrogen, and potassium. According to one estimate, about 700,000 tons of phosphorus, 800,000 tons of nitrogen and 4,700 tons of potassium are discharged into the nation's streams each year from domestic sources. This would be equivalent to between 10 and 15 percent of the country's current fertilizer consumption for these nutrients if they could be fully recaptured.

The nutrient constitutents and value of wastewater varies from place to place, as do the nutrient uptake capacities of plants. Thus, careful monitoring is needed to be certain that an optimal balance between wastewater irrigation rates and plant uptake capacities is achieved.

In many areas, the nutrients in the wastewater may be in just about the right proportion for good crop yields. But in some areas, fertilizer supplements may be needed to achieve optimal results and to maximize economic return. Muskegon County, Michigan, for example, irrigates over 4,000 acres with wastewater which is low in nitrogen content. (This is because of low nitrogen levels in industrial wastewater that is discharged into the county system.) Moreover, the site, comprised of glacial till and sandy soil, is of poor quality for crop production. The county, therefore, supplements wastewater nitrogen with additional nitrogen fertilizer in order to assure optimal corn production.

Despite the poor soil at the Muskegon site, corn yields increased quickly after the program began in 1974. Before irrigation, yields were about 28 bushels per acre; by 1975, with irrigation, they had approximated the county average of 65 bushels per acre. Yields between 65 and 80 acres a bushel are now routine. Muskegon estimates that the value of the nutrients as fertilizer is over $110,000 per year.

The constituents of wastewater vary, but all contain salts which can accumulate in the soil and retard plant growth. In some areas, the quality of wastewater for irrigation may actually be better than standard irrigation supplies. But in other areas, special management practices may be needed to minimize effects on the soil. The effects of salt build up on crop production will depend not only on its concentration in the wastewater, but also the kind of soil, whether the crop is relatively salt tolerant, and the experience of the operator in managing salt problems.

Farmers need assurance that wastewater delivered to them for irrigation is of good quality. This means that municipalities need to take precautions to be sure that salt concentrations are within acceptable limits for irrigation, and that toxic materials and other pollutants are removed before delivery to the farmer.

How Can Both Private and Public Interests be Safeguarded?

In working out the details of wastewater irrigation, special care needs to be taken to assure that the system meets both pollution control and agricultural objectives.

One especially important concern is the rate of wastewater application. Municipalities continually produce wastewater, but farmers only irrigate when the circumstances are right for agriculture. Ways around this problem include construction of storage reservoirs (sometimes by the city, sometimes by the farmer, sometimes by both) to hold excess water, or alternative disposal arrangements when there is a disjunction between the city's need to dispose of the water and the farmer's ability to accept the water for good irrigation practices.

For farm operators, a major concern is the quality of the wastewater for irrigation. Careful monitoring by the city is needed to guard against changes in municipal wastewater constituents that could adversely affect crop yields and soil conditions on irrigated sites. When problems do arise, appropriate measures need to be taken to maintain the quality of the wastewater. Most agreements between cities and landowners require the city to deliver wastewater that is suitable for crop irrigation.

To protect both public and private interests, a long term agreement is ususally desirable. This gives both municipalities and landowners a basis for effective planning.

These are normally matters that can be resolved relatively simply through close interaction between the community and the landowner. Agreements generally spell out the landowner's responsibility for helping to meet public objectives in water quality management, and the community's responsibility for assuring that the quantity and quality of the wastewater delivered will be right for the landowners needs.

What About Soil and Groundwater Contamination and Health Risks?

No major health or contamination problems have been reported among those communities currently using land treatment, and most studies have concluded that a properly designed and operated wastewater irrigation system is likely to pose less environmental and public health probems that most other treatment technologies. But it is not risk free.

Pathogens and viruses are one potential problem. Domestic wastewater contains organisms which can cause disease if left unchecked. As with conventional methods of wastewater treatment, chlorination or other control of indicator organisms is usually employed in land treatment, and other practices can be employed to minimize contact between humans and disease organisms.

For example, more stringent precautions need to be taken when wastewater is used to grow vegetable or fruit crops which may be consumed without washing or cooking, than for processed food or fodder crops. Some communities (and states) avoid ths problem altogether by only permitting wastewater irrigation to be used for production of grain and forage crops.

Another concern is that irrigation workers or people living near land treatment sites could contract diseases. When wastewater is sprayed, a portion of the liquid is turned into aerosols—tiny particles of airborne water that can carry disease organisms. Most of the disease organisms quickly die off, but there is a chance of inhalation of pathogens by humans. Although the extent of risk has yet to be established, disinfection, buffer zones around the site, avoidance of sprinklers that create an overly fine mist, and not spraying in high winds are among the measures that could reduce whatever level of risk there is.

One frequently voiced concern about land treatment is that it might lead to build up of heavy metals or trace elements (such as cadmium, lead, mercury and zinc) in the food chain or groundwater. All municipal wastewater contains such elements in small concentrations; when industrial wastes are discharged into the municipal

system, far higher concentrations can occur, depending upon the kind of industry and its size.

In small concentrations, some of these metals (such as zinc) may actually have beneficial effects, since many land areas have too little of this element for optimal plant growth. But all can be hazardous or even acutely toxic if concentated in the food chain, and can affect certain soils adversely.

Studies in this country have not reported significant problems with metal build-ups in areas using wastewater irrigation for decades, but heavy metal concentration in the food chain may be a potential problem. Careful monitoring and control is therefore necessary. Choice of crops is important, since some plants accumulate heavy metals faster than others. Where municipal and industrial wastewater are mixed, pretreatment by the industry may be needed to reduce metal concentrations before it is collected by the municipal system.

Care also needs to be taken to guard against possible build up of nitrogen in groundwater. Done properly, wastewater irrigation is highly effective in recycling nitrogen, but if nitrogen concentrations in the wastewater exceed the assimilative capacities of the soil or plants, nitrates may contaminate the groundwater or run off to streams. On a good site, and with careful monitoring of wastewater, this is not likely to be a problem. But adjustment in wastewater application rates may sometimes be needed.

Phosphorus, also, can sometimes be a problem. Phosphorus can build up in the soil, adhere to soil particles or remain in solution and run off into surface waters. Less is known about phosphorus removal mechanisms in wastewater irrigation, but potential problems can be dealt with by selecting crops that recycle relatively large amounts of phosphorus, double cropping where feasible, and use of erosion control techniques to prevent runoff into surface waters.

While care is needed, the safety record of wastewater irrigation is very high. No incidents of disease from a well planned and properly operated system have been reported. Nonetheless, the long term effects of land treatment for the soil, the water and for health will be the subject of continuing investigation and research.

Case Studies of Wastewater Irrigation

Wastewater irrigation is not just a pollution control technique: it can be used to meet a variety of community objectives. The brief case studies that follow demonstrate a variety of innovative ways in which communities have

Northglenn, Colorado

In much of the West, agriculture and urbanization are in pitched battle over water allocation. As the population increases, pressures to divert water from irrigation agriculture intensify. Finding ways to accommodate both urban and agricultural water needs is thus a pressing need.

Northglenn, a Denver suburb of about 30,000, may have found a way to satisfy both interests, at least temporarily, through an innovative wastewater irrigation program. Central to this solution is an agreement between the city and a local irrigation company, the Farmers Reservoir and Irrigation Company (FRICO), in which the company will deliver water to the city for municipal use, while the city will treat the wastewater, supplement it with other city controlled supplies, and return it to farmers for irrigation.

Northglenn's program grew out of decades of explosive growth outside of Denver. This resulted not only in competition between ubanization and agriculture for water, but also competition aong the new communities themselves. Northglenn was concerned about its dependency for its water supply on a nearby, fast growing community, which itself was rapidly over stretching its abilities to meet water demands. Northglenn feared that it might have to buy higher priced water on the market. Complicating the situation was a proposed regional sewage treatment plan, which would much improve water quality, but result in higher sewerage charges for Northglenn residents.

In the crunch to provide water for new growth, local farmers stood to lose in a big way. Under Colorado water law, urban areas can condemn irrigation water rights. Condemnation actions were being taken against FRICO to divert water from irrigation to urban uses, and efforts to get the Colorado legislature to intervene on the part of local farmers were not succeeding. As a result, area farmers could expect to lose irrigation water for about 40,000 acres of cropland.

These pressures caused Northglenn and FRICO to develop a very innovative approach to address both water pollution and water supply problems. FRICO's water (much of it collected from high quality spring snow melt from the Rocky Mountains) is stored in nearby Standley Lake for later distibution to FRICO company owners. Under the town-irrigation company agreement, much of the Standley Lake water which originally was released directly to irrigators will go first to Northglenn for municipal use. After use, the town will collect the water, treat it, and return it to the farmers for irrigation. As payment to FRICO, the town has agreed to return 10 percent more water than FRICO delivers to it. (To accomplish this, the town will pump water from deep wells and collect storm water.) Since the irrigators no longer draw water directly from the Standley reservoir, the city has also agreed to construct a winter storage reservoir which will hold the water until it s needed by irrigators. To assure the quality of the irrigation water, the city is providing a higher than normal level of pretreatment before diverting the water for irrigation.

Although it is too soon to tell whether it will suceed, the Northglenn-FRICO approach may ultimately have a stabilizing influence on local agriculture, which, for decades, has been losing out to urban growth. The agreement expressly states that Northglenn makes no claim to FRICO water rights. Since FRICO is not obligated to provide any more water than the city can return, this constraint on water availability may help the town keep within its maximum population projection of 45,000 people.

used the solution to one problem—municipal wastewater disposal—to help solve other problems. All have one thing in common: a great deal of interaction betwen public officials, landowners, and others to work out an effective program.

El Reno, Oklahoma

El Reno, a town of abut 25,000, is another example of a western town that has adopted an innovative land treatment plan. The approach is intended to help the city achieve multiple objectives—water conservation, improved municipal water supplies, and encouragement of agricultural production—in addition to effective wastewater treatment.

Like many western towns, El Reno has had to contend with serious water quality and water supply problems. New growth was intensifying competition for water, and in turn was affecting the quality of water supplies for domestic and agricultural use.

Prior to adopting a land treatment approach, the city employed conventional secondary treatment of wastewater. The effluent was discharged into the nearby North Canadian River, which in turn had become highly polluted. The pollution was a matter of growing concern. The North Canadian, and its downstream reservoirs, proided municipal water for Oklahoma City, 25 miles from El Reno, and was significant for recreational use. Moreover, the shallow alluvium of the river recharged the aquifier which provided ground water supplies for El Reno itself, several downsteam municipalities, and irrigation agriculture.

Faced with State and Federal requirements to provide higher levels of wastewater treatment, El Reno began to assess its options in the early 1970s, with the help of a consulting firm specializing in sanitary engineering, goundwater geology, and irrigation agriculture. After thorough assessment, El Reno opted for an approach which, in the words of the consulting firm, considers the total water resource situation of the river valley.

The key element in El Reno's program is an agreement with a local farmer, worked out after considerable negotiation (see box), which involves a kind of "swap" of groundwater for wastewater. Under the contract, the farmer will irrigate 465 acres of his land with El Reno wastewater for a 20 year period.

The city is delivering its wastewater after pretreatment in a series of storage lagoons. The wastewater is to be suitble in quality for irrigation, and the city is responsible for monitoring to assure such standards are met. The city is also furnishing center-pivot irrigation sprinklers, all water lines, pumping equipment and power for transporting the wastewater to the farmer's irrigation site—located two miles from the storage lagoons.

In return, the farmer is transfering to the city groundwater rights under the 465 acres to guard against future overdrafts of the Canadian River aquifer. The farmer is also responsible for applying the wastewater to his land—which will save the city an estimated $5,000 to $10,000 a year in application expenses. In addition, the farmer has agreed to pay the city $5,000 per year for nutrients in the wastewater and for use of city supplied and installed center pivot spray irrigation equipment. The farmer can expand wastewater irrigation to additional land at his own expense, but, in return, must convey additional groundwater rights to the city.

Building Cooperation with Landowners

What steps can the community take to assure early landowner involvement in wastewater irrigation programs? The specifics will vary in each case, but El Reno and the consulting firm the city hired worked out an approach designed to meet both the community's and the landowners needs.

When El Reno, Oklahoma began to develop its program in the early 1970s, the city was undecided about the best approach to follow—land acquisition, lease arrangements, or contracts with local landowners. It hired a consulting firm to explore these alternatives, and propose a workable system.

Early in the planning process, discussions with local farmers were held to determine who was interested in wastewater irrigation, what they thought the best approach would be, and any concerns they had about using wastewater for irrigation. This was followed up with further discussion with seriously interested landowners once the project reached the design phase. To help the city and the farmers in these discussions, Frank Gray, a Lubbock, Texas farmer (see page 10) with over 40 years of experience in wastewater treatment, met with local farmers.

The city then requested landowners to submit proposals. After selecting the proposal that met the city's objectives to the greatest degree, further negotiation was undertaken before a final contract with the farmer was approved. The consulting firm noted that "the meetings with farmer groups promoted an atmosphere of competition which forced the contract approach to be the best method for securing the land areas." This seems to be borne out by the agreement ultimately reached between the farmer and the city, which provides a mixture of responsibilities on the part of the two parties, as is detailed above.

Clayton Couty, Georgia

A suburb of Atlanta, Clayton County is using wastewater to irrigate forest land. Georgia's ninth largest county in terms of population, the County began to assess alternative systems for cleaning up wastewater in the early 1970's, when it became apparent that new growth would so add to effluent discharges that the county would not be able to meet State water quality standards. The situation was compounded by the fact that the county derived most of its potable water from streams which also received municipal effluents.

Faced with the possibility that a no-growth strategy would be necessary if conventional treatment were used, the county opted for wastewater irrigation—an approach which would not only result in zero discharge into the water, but could also help augment local water supplies.

Clayton was able to benefit from the experience and good results of an experimental land treatment system, established in 1973 on the Uncoi State Park in the Blue Ridge mountains about 100 miles north of Atlanta. The Uncoi project was intended to demonstrate the feasibility of land treatment on steep forested slopes in the southern Appalachians, and to develop guidelines for the design of similar systems in the area. The Uncoi experiment, applying wastewater from park visitor facilities, proved successful: data after three years showed a 98.7% reduction in phosphorus; 78 percent reduction in calcium and a 90 percent reduction in potassium. The system's effectiveness in reducing nitrogen was less certain.

Clayton's irrigation program takes place on a 3,500 acre, moderately steep site, most of which is forested with loblolly pine, with grass at the bottom of the slope. A forest management program has been adopted to maintain hydrologic conditions, and also to maintain rapid growth of trees, which will be harvested on a 20 year rotation. Because young trees are more effective in recycling nitrogen, this short rotation should not only provide an economic return, but also make the system more effective in reducing pollution. Experience in other areas that have used wastewater to irrigate forestland suggests that rapid growth in yields can occur. This is effective from a wastewater management point of view, and also increases returns from the land.

Making Sure that Resource Values are Considered

Making sure that wastewater irrigation occurs on a good site and under the proper conditions is a concern in all areas where the technique is being used. Few wastewater treatment agencies have this capability themselves, but, in most areas, local soil and water conservation districts, the Soil Conservation Service, (SCS) other resource agencies can be of considerable help in hand tailoring a program to meet local resource protection objectives.

In Clayton County, both SCS and the Upper Ocmulgee Soil and Water Conservation District have been deeply involved in the design and implementation of the county's program. Early on, they provided soils data to the county water authority and to the engineering firm which worked on the plan. This helped the county to determine which land areas had the most usable soils for wastewater irrigation. SCS and the Upper Ocmulgee Conservation District then made a detailed soils analysis of the site to determine potential irrigation capabilities, infiltration rates, and other physical characteristics of the land. The district and SCS have also developed standards and specifications for revegetating all critical areas on the site—an especially important concern on the steeply sloped land. The Upper Ocmulgee Conservation District has established a test plot on the site to determine what effects the added nutrient and moisture would have on grasses, and is continuing to monitor the results. One important part of the Clayton program is public education: tours are conducted for interested parties to look at the wastewater land treatment system.

The Clayton program, designed to purify the water, to improve local water supplies and to provide some offsetting income from forest products, clearly has multiple use benefits. Says Silas Elliott, Chairman of the Upper Ocmulgee Conservation District: "Application of wastewater to land enables us to use the water twice and let nature do the recycling job instead of using expensive energy and other resources to do it."

East Windsor, New Jersey

East Windsor Township, located within commuting range of both Philadelphia and New York, turned to wastewater irrigation to help solve water pollution problems arising from explosive growth. Between 1960 and 1970, East Windsor grew from 2,000 people to 20,000. The township grew so quickly that the New Jersey Department of Environmental Protection imposed a moratorium on new sewer connections in 1972 in order to prevent further overloading of the municipal sewage treatment facility. The moratorium stayed in effect for three years, as the township worked out an affordable pollution control strategy. It initially proposed to triple the capacity of its existing secondary sewage treatment facility, using advanced techniques to reduce nitrogen and phosphorus concentrations before discharging effluents in the nearby Millstone River. But, the state ruled that even these advanced techniques would not be adequate to protect water quality in the river.

As a result, the East Windsor Municipal Authority turned to spray irrigation of its wastewater, which was found to be the only alternative which would permit the community to meet state water quality requiements and still permit existing commitments for sewer hookups to be met. East Windsor's spray irrigation system—designed to eventually accommodate 2.23 million gallons of wastewater a day—is one of the largest in the Northeast.

All sewage is given secondary, biological treatment (involving activated sludge processes) to reduce organic matter. It is then given additional treatment in an aerated lagoon, capable of holding 9.0 million gallons of wastewater, and is chlorinated.

During the winter months, when the assimilative capacity of the river is high and conditions are not right for spray irrigation, all of the effluent is discharged into the river. In the growing season, part of the effluent is discharged directly into the river, but the remainder (about 1.23 million gallons per day) is sprayed on an 80 acre site, planted with reed canary grass. This species does well in wet conditions and has excellent capabilities to recycle nutrients. The township harvests the grass three times a year and sells it to farmers and homeowners for mulch, fodder and fertilizer. This helps offset treatment costs, and also has some value locally for farm and garden activities. A 20 acre buffer zone has been established around the site, located close to the river, to reduce runoff, and a Scotch Pine wind screen has been established to prevent aerosol carryover to a nearby highway.

The East Windsor spray irrigation system is another example of a program that was developed with close coordination between municipal wastewater treatment officials and agricultural and conservation specialists. The consulting engineer for the project obtained soils, design and layout assistance through the Mercer County Soil and Water Conservation District. The Mercer County District was also very active in applying its resources to help improve environmental quality on the site. The Soil Conservation Service directed drilling of the site to determine soil capabilities, drainage patterns, water table information and other site characteristics necessary to determine rates. This was followed by a detailed drainage land, recommending land smoothing, subsurface drainage, and spray irrigation. The State extension service also provided assistance in developing the program.

Dickenson, North Dakota

Dickenson, North Dakota, is a small town of about 13,500 that serves as a primary service center for agriculture and ranching, and is the site of one of the major cattle auctions in the Northern Great Plains. The town has been using wastewater irrigation since 1958. This system was expanded in 1972, because of population growth associated with increased energy development in the area, and again (in 1977) to install, among other things, a 58 acre winter storage lagoon. Three quarters of the 1977 modifications were paid for by a grant from the U.S. Environmental Protection Agency; the remainder, by the town.

Dickenson provides its wastewater effluent to a farmer adjacent to the facility, who uses it for crop irrigation (primarily alfalfa). The irrigation system involves two center-pivot irrigation systems (each involving 98 acres) and flood irrigation on another 18 acres, which is leased to the farmer by the city but has been developed for irrigation purposes by the farmer. Application rates average between 16 and 22 inches per year.

The city and the farmer have entered into a cooperative agreement, designed to meet both public and private objectives. The city assumes energy costs associated with pumping the wastewater, while the farmer agrees to receive the wastewater, subject to reasonable controls required for good farming practices. If the city wishes to irrigate to drain its lagoons, it assumes labor costs, and responsibility for possible damages from negligence. The farmer is authorized to irrigate at any time, with approval of the local water superintendent, but in such cases furnishes his own labor.

Because the Dickenson project has been in operation for over 17 years, it has been the subject of detailed study by EPA. (See box on below.) The agency concluded tht use of wastewater for irrigation at Dickenson has had several long term beneficial effects, and noted that "all parameters observed for the groundwater, soils and plants support the continued use and longevity of the test site, for continued effluent irrigation crop benefits, and for continued effluent irrigation crop benefits, and for continued wastewater reclamation.

Long-Term Effects of Wastewater Irrigation of Treatment Sites

What are the long term effects of wastewater irrigation on the soil and groundwater? To help answer that question, the EPA has been conducting field research at several sites around the country that have used wastewater irrigation for several years.

In Dickenson, North Dakota, which has been conducting wastewater irrigation since 1958, EPA concluded that "an analysis of the waters, soils and plants indicated that the use of wastewater for irrigation resulted in several long term beneficial effects." The agency found no evidence that coliform bacteria were contaminating the grass crop on the site. There was some evidence of higher levels of metals in the grass, but this was well within the normal range for the species. Toxic metals were absent from the effluent, groundwater and irrigated crop. As for nutrients there was evidence of increased concentrations of nitrogen and phosphorus in the test site soils as compared to a control site. Somewhat more nitrogen filtered through to the groundwater than was the case on the control site. The study estimated that the irrigation site could effectively remove phosphorus from the effluent for over 100 years without significant problems.

At Tooele, Utah, which has been using wastewater irrigation since 1957, EPA also found no evidence of significant long term problems. Soils analyses indicated no accumulation of nitrogen, lead, zinc, copper, chromium, nickel or soluble salts as a result of wastewater application. The treated site did have concentrations of available phosphorus that were five to six times greater than the control site to a soil depth of 10 feet. But, the study concluded that "no harmful effects on soils, crops, or water quality" have occurred from land application of secondary effluents on the site in the 20 year period.

Another EPA sponsored study compared wastewater land treatment sites in Lubbock, Texas (see page 33) and Bakersfield, California. Parts of both sites had been irrigated with wastewater for over 35 years at the time of the study. The study concluded that, with the exception of phosphorus concentration, "soil chemical properties were not markedly affected by the sewage effluent.
sewage effluent irrigations. Long-term irrigations with sewage effluent have caused very little changes in the chemical composition of plants grown on the site." The report did note that, on both sites, unacceptble concentrations of nitrates in groundwaters was a possibility. But this problem could be corrected by effluent storage during the winter months.

Vandalia, Missouri

Vandalia provides an example of how changing economic conditions have made wastewater irrigation a more attractive benefit for farmers. In 1957, the City of Vandalia purchased about 30 acres of farmland from L.E. Kohl, a local farmer to build a sewage lagoon. Kohl was displeased about the action at the time, in part because of the loss of 30 acres of good farmland, in part because of concern about odor. In practice, however, the sewage lagoon has turned out to be a good neighbor. Not only have undesirable odors not occurred, but Kohl's right to outflow or overflow water from the lagoon has provided economic benefits.

Initially, Kohl used the outfall to water his livestock—not for irrigation. By 1974, however, Kohl had concluded that rising land costs and increasing costs of crop production justified irrigation. After assessing other sources of irrigation water, Kohl concluded: "The city sewage lagoon appeared to be a valuable untapped source of water and I decided to try it."

Kohl invested about $28,000 in equipment to bring 240 acres of corn under irrigation—at an average equipment cost of $116 per acre. His investment appears to have been justified. In his first three years of irrigation, Kohl's corn yields on irrigated land averaged 103 bushels per acre, while dry land yields were 59 bushels. At $2.35 per bushel, the 1977 corn price, gross returns on the irrigated land were $103 an acre above those on dry land.

Kohl's initial success led him to expand the system, in order to bring another 160 acres under irrigation. He has built, at his own expense, a 200 acre foot storage reservoir which will be filled with wastewater previously discharged into the stream during the winter months by the city. The storage reservoir, covering 20 acres of his own land, cost Kohl $38,000 in construction costs. Because the additional irrigation land is located a mile from the storage reservoir, Kohl also spent another $21,000 for pipelines and to obtain easements from two neighboring farms.

Since Kohl's reservoir will help the city meet the zero discharge goal of Federal water pollution control laws, the city is constructing a 900 foot pipeline from the sewage lagoon to Kohl's reservoir.

In developing the system, Kohl has had assistance from local agricultural personnel. The Rolls County Soil and Water Conservation District, located in New London, Missouri, has provided technical assistance. The Soil Conservation Service technician assigned to the District assisted with development of the plan for the new lagoon and irrigation system, staked out the work and supervised construction. In order to assure against possible long term problems, Kohl is cooperating with local extension agents, who are conducting soil and tissue tests on both irrigated and non-irrigated crops. This will help determine whether undesirable side-effects will occur.

Summing up his experience, Kohl concludes: "There are a limited number of persons who can use municipal effluent or lagoon water for irrigation, but I'd certainly encourage any farmers located within reasonable distance from a municipality to tap the unused source of water. I'd also encourage any municipality who has a problem complying with the zero discharge requirements of the future to look for a farmer interested in a water source for irrigation and develop a plan for mutual benefit."

Lubbock, Texas

In 1937, Lubbock, than a small town located in the high plains of west Texas, entered into a contract with a local farmer to take municipal wastewater to irrigate his farm. In the four decades following, the city and the farmer have cooperated to undertake one of the most successful examples of wastewater irrigation in the country.

The farmer is Frank Gray, a long time cooperator and director in the local soil and water conservation district, and former chairman of the Texas State Soil and Water Conservation Board. Gray's wastewater irrigation system, one of the oldest on-farm systems of its kind in the country, has helped to make his farm a kind of model for good conservation treatment and management practices.

As Lubbock has grown—today it is a city of over 150,000—so has Gray's operation. In the 1930's, the city contracted for the disposal of about one and a half million gallons of municipal wastewater per day—requiring about 200 acres. Today, Gray irrigates about 5,000 acres with about 20 million gallons of wastewater a day.

The benefits to both Lubbock and Gray are readily apparent. The city gets a low-cost, dependable way to dispose of its wastewater, without incurring the additional costs of tertiary treatment. As part of his agreement with the city, Gray has taken measures to prevent any wastewater runoff from his land. This prevents water pollution, and allows recycling of water, which is delivered to the cooling towers of a nearby power plant.

Gray's farm receives all the irrigation water it needs (delivered after biological treatment), and all the fertilizer needed for high production levels. Nitrogen, phosphorus and potash in Lubbock's wastewater are estimated to be worth about $15 to $20 per acre a year. This allows Gray to achieve high crop yields without adding commercial fertilizer.

Because of the no runoff requirement, Gray uses some of his land to permit infiltration of wastewater. This has helped recharge groundwater levels (notoriously low in this part of Texas), but has also increased groundwater nitrate levels near the surface. Plans are underway to recapture the groundwater for irrigation through wells. This should recycle the nitrates, and reduce concentrations in the groundwater. However, the high nitrogen content of the groundwater suggests caution when contemplating the use of effluent for recharge purposes.

Lubbock's growth rate has out-paced Gray's operation. As a result, Gray has worked with the city, the Lubbock Christian Church, and the Environmental Protection Agency to develop a new wastewater irrigation system 10 miles south of the city.

Plans call for the construction of a 36 inch pipeline to deliver effluent to the new 4,000 acre site, purchased by Lubbock Christian College. The water will be used by several tenant farmers who have watched their crops dwindle to nearly nothing in recent years as groundwater depletion, along with rising prices of natural gas, have made irrigation by wells uneconomical.

The expansion of Lubbock's wastewater system also provides many research opportunities. Soils tht have never been irrigated with effluent can be compared with nearby soils that have been treated for 40 years with wastewater. Increases in nutrients, harmful salts, and crop yields can be measured. Water tables can be monitored, and water quality checked. Farm economics, as well as costs for wastewater disposal can be evaluated, and potential health effects can be determined.

The Voice of Experience

What are the lessons to be learned from Frank Gray's 40 years of experience with wastewater irrigation? He identifies several key factors that are necessary for the success of wastewater irrigation on private land:

- A long term contract between the city and the farmer so each can plan ahead.
- Close control of municipal sewer uses so that toxic chemicals or metals are not introduced.
- Adequate storage and water routing facilities so that water can be held when conditions are not right for irrigation.
- Level land, so that the water can be applied quickly and uniformly over the fields.
- High levels of soil organic matter to improve water intake rates and soil aeration.
- Proper crop management to maximize water and nutrient uptake.
- Matching the type of crops grown, the crop rotation, and the acreage irrigated to the volume of water in the system.

There are still many questions to be answered about wastewater irrigation: will there be soil buildup of harmful salts or metals? Will groundwater be polluted? Will there be health effects for farm workers and the public at large? Gray has ideas, if not complete answers, on many of these questions. His own health appears not to have been affected by over 40 years of wastewater irrigation. As for concerns about land degradation, Gray points to a robust cotton crop grown without added fertilizer on a field that has been a wastewater irrigation site for 40 years. "If that's ruined soil," he quips, "I'd like to have lots moe of it."

Federal Assistance

The current "push" towards land treatment owes its origin in part to requirements and incentives provided by Federal water pollution control programs, administered by the U.S. Environmental Protection Agency. Two major acts, the Federal Water Pollution Control Act Amendments of 1972 and the Clean Water Act of 1977 are especially important (see Appendix II for the relevant provisions). The 1972 Amendments established the basic strategy for water pollution control, while the 1977 Clean Water Act provided mid-course adjustments almost always needed in major programs.

The 1972 Act established a goal of "zero discharge" of effluent into the nation's water bodies by 1985. To meet this goal, the Act, among other things, established a m ajor program of construction grants and loans to assist municipalities in upgrading sewage treatment facilities. As part of the construction grant program, the 1972 Act encouraged localities to look into "innovative and alternative technologies" (such as land treatment) as one way to keep costs down and still accomplish water quality objectives.

The 1977 Clean Water Act focuses increased emphasis on these "innovative alternative" methods through a variety of requirements and incentives by specifying, among other things, that:

- EPA will not make grants for construction, acquisition, improving or extending treatment works unless the applicant demonstrates that innovative and alternative methods have been "fully studied and evaluated."

- Federal grants for innovative and alternative methods will cover 85 percent of construction costs, rather than just 75 percent as is the case for conventional facilities. Moreover, alternative and innovative techniques will be given priority over conventional techniques if cost analysis reveals that total costs over the life of the facility is not more than 15 percent greater than costs of conventional treatment.

The Federal grant provisions allow communities to use part of their grant to purchase land for both storage of wastewater prior to its application and for purchase of land that is an integral part of the treatment system. EPA has decided that, in situations where leasing land or easements to land will be more cost effective then fee simple acquisition, grant funds can be used for this purpose. However, in such cases, special precautions need to be taken to assure that leases or easements are not prematurely terminated, and that conditions of the lease will be met. EPA has noted that, in situations where water or nutrients are of value, options such as sale or donation of effluents should be used rather than leasing or land acquisition.

- As a condition for receiving grants, communities are to analyze open space and public recreation potential of lands, waters and rights of way which are part of proposed projects. They are also to consider processes and techniques which reduce total energy consumption. Land treatment frequently results in lower energy expenditures, and open space benefits.

The Act also recognized the special problems faced by small communities and rural areas in meeting clean water objectives. In the past, rural areas have often been overlooked, or pressured into building high volume conventional facilities. The 1977 Act included several provisions designed to assist such areas. Among them:

- States with rural populations exceeding 25 percent are to set aside four percent of their grant fund for alternative techologies employed by communities of 3,500 or less, or for highly dispersed sections of larger communities.

- Communities under 25,000 can combine project design and construction phases for projects with costs under $2 million (or, in some cases, $3 million) in order to save money, reduce delays and facilitate planning.

- EPA, at the request of such communities, can provide technical and legal assistance in administering and enforcing contracts for planning, designing and constructing facilities.

The Role of Conservation Districts in Land Treatment

Wastewater irrigation provides a classic case where the objectives of national policy—assuring cost-effective control of water pollution—can help achieve a variety of local objectives, both public and private. For these objectives to be met, however, the active participation of farmers, landowners, soil and natural resource specialists, conservationists and other segments of the public is not only essential in gaining overall approval of a program, but also in the actual implementation of the program itself.

The need for continuing involvement of a variety of people not used to working with each other is thus one of the key challenges of wastewater irrigation. How can this be assured? The answer will differ in each community, but in many areas that already have or are considering wastewater land treatment programs, local soil and water conservation districts have played an important role. Districts, which are local units of state government, have a long history of working with landusers and the public to achieve national or state resource managment objectives in a way that is consistent with private needs (see box on page 12).

Over the years, as natural resource management and environmental objectives have broadened, districts have expanded their programs to include other components besides soil and water conservation objectives. They have, for example, become deeply involved in the effort to develop plans to reduce water pollution stemming from agricultural non-point pollution, first called for under Section 208 of the Federal Water Pollution Control Act Amendments of 1972. Other areas of district involvement include coastal zone management, surface mine reclamation, urban conservation, and numerous other activities. Working with landowners and land users to achieve a total soil and water conservation program is a fundamental characteristic of all district activities.

Following is a list of district "action potentials" which has been developed to show the range of activities relevant to wastewater land treatment which municipalities and individuals might wish to consider.

Action Potentials

How can districts benefit from involvement in wastewater land treatment programs?

- By helping to assure that local wastewater land treatment programs fully reflect district concerns about wise use and stewardship of land resources.
- By furthering local resource conservation objectives, such as improved crop production, water re-use, energy conservation, and enhancement of recreation potentials on public or private land.
- By improving coordination between district involvement in agricultural non-point pollution activities carried out under section 208 of the Federal Water Pollution Control Act and other aspects of water pollution control programs.
- By increasing the capabilities of districts, municipal water pollution control authorities, and local land users to work together to solve important community problems.

How can districts become involved?

- Make district expertise, technical capabilities and other resources known to State and local water pollution control authorities.
- Seek involvement early in the planning stages of municipal facilities, in order to help determine whether wastewater land treatment is a viable option within the community.
- Identify and assist local landowners and land users that are interested in participating in wastewater land treatment programs.
- Offer to assist in the design, implementation and monitoring of wastewater land treatment programs.
- Provide information and educational services to landowners and the community throughout the process.

How can wastewater treatment authorities benefit from district involvement in land treatment programs?

- In most states, district enabling legislation gives conservation districts the authority to enter into agreements with other State or local agencies to undertake irrigation-related activities. Through agreement with municipal treatment authorities, districts in many areas could undertake and/or oversee implementation of the irrigation aspects of a wastewater land treatment program.
- Conservation districts can help bring local landowners together with municipal authorities and work to see that the interests of both are met.
- Districts can provide local coordination of resource management professionals necessary to design a proper land treatment approach.
- Districts can help localities identify and assess the land treatment technique and uses (crop production, land restoration, open space protection, water re-use and so forth) which makes the most sense locally from a natural resource point of view.
- Districts can help to identify and assess suitable sites for wastewater land treatment.
- Districts can work with municipalities and landowners to work out a wastewater land treatment program that is compatible with soil and water conservation objectives, and local environmental needs and conditions.

What Are Soil and Water Conservation Districts?

During the dust bowl days of the 1930s, protection of soil and water resources became a high priority national issue. In 1935, the Soil Conservation Service was created to implement a continuing program of soil and water conservation. Shortly thereafter, the Department of Agriculture proposed the formation of local soil conservation associations to over see SCS assistance for erosion control projects on private lands.

Out of this idea was borne the soil and water conservation district. In 1937, President Franklin D. Roosevelt transmitted to state governors model conservation district enabling legislation. Soon, every state, Puerto Rico and the Virgin Islands had passed laws creating conservation districts. Today, nearly 3,000 local districts cover more than 99 percent of the nation.

Districts are local units of State government, which are governed by over 17,000 local citizens, repesenting a range of occupations. They exist independent of, but partner to, the resource conservation programs of the Federal government. Under a memorandum of understanding signed by each district and the Secretary of Agriculture, the SCS provides technical assistance to the district and its cooperation land users.

From the beginning, provision of assistance to land users has been a key component of the individual district program. Upon request of the landowner, the district works with individual land users to develop conservation plans tailored to meet resource conservation objectives along with the user's skills and needs. The plan defines appropriate conservation measures and alternative courses of action for the land user. Voluntary in nature, it is up to the land user to undertake conservation practices. But districts also provide technical assistance on a continuing basis when requested.

Another key district activity is the local conservation program. In many areas, districts elicit cooperation among local, State and Federal agencies, and provide services on natural resource matters to local governments. Uniquely equipped to provide a sense of local priorities on resource issues, districts have become, for many localities, a kind of de facto natural resource department. Most districts also undertake public information and education projects, encouragement of needed reseach and other out-reach activities.

Just as the district concept spread rapidly, so the work of districts has expanded to cover a broad range of resource conservation and development concerns in addition to soil and water conservation objectives. Conservation districts have played a major role in developing agricultural non-point pollution plans required by Federal water pollution control legislation. Over half the country's conservation districts are working with local governments, developers and engineers to develop effective urban conservation programs. Many coastal districts are helping facilitate cooperation between landowners and State or Federal officials in furthering effective coastal zone management plans. Surface mine reclamation and wetlands protection are among the many other concerns of local districts. Although no formal program of district involvement in wastewater land treatment exists, many districts throughout the coutry have played key roles in developing local wastewater irrigation approaches.

What specific services can districts provide to municipal officials and landowners?

Soil and Natural Resource Information and Analysis:

- Provision of soils information needed to interpret the potential suitability of cropland, forests, range and other land as sites for wastewater land treatment.
- Provision of inventories on wind and water erosion and sediment delivery.
- Provision of information about adapted plants or crops for each type or group of soils.
- Provision of technical abililty for interpreting alredy existing data.
- Ability to coordinate resource management professionals to bring together the necessary technical expertise to determine acceptability of sites.

Design of a Wastewater Irrigation Program:

- Identifying and assessing options and alternative uses for wstewater land treatment.
- Meeting with landowners to determine their interest and concerns about wastewater land treatment.
- Designing a wastewater land treatment program that meets soil, water and other conservation objectives.
- Advising and assisting wastewater treatment agencies about ways to incorporate resource data and objectives into wastewater land treatment programs.

Technical Assistance to Landowners and Communities.

- On-site assistance to land users and/or communities in developing a wastewater land treatment program that meets their individual needs, water quality objectives and the needs of the land.
- Assistance to land users, including information about the potential of the land for wastewater irrigation, limitations or risks associated with wastewater application on their land, and alternative conservation practices necessary to protect and maintain land quality and productivity.
- Assistance in using wastewater land treatment as a means to reclaim or stabilize surface mined areas and marginal land.
- Engineering assistance (through the Soil Conservation Service) on grade stabilization, terraces, surface and subsurface drainage practices, and other necessary improvements to meet water pollution control and soil and water conservation objectives.
- Assistance to land users for the installation and maintenance of conservation practices and resources that meet the objectives of the land user and in turn achieve water quality and other resource objectives.
- Technical assistance to landowners and communities in designing, laying out and checking the construction of terraces, surface and subsurface drains; in selecting plant varieties for wastewater irrigation that meet the best combination of public and private objectives; in identifying seeding methods and cultural practices to establish grass or trees as planned; and in solving problems that arise in managing cropland, woodland and other land as wastewater irrigation takes place.

Monitoring and Follow-up

- Assisting with monitoring of the effects of wastewater irrigation on plants and crops, the soil, and on the quality of wastewater.
- Identifying potential problems arising from wastewater land treatment.
- Suggesting changes in land management practices to deal with any problems that arise.
- Coordinating and/or conducting research related to the effects of wastewater irrigation on crops, soils, water and the land.

OutOut-Reach Activities

- Coordinating with local, state and federal agencies, universities, and others involved in wastewater irrigation projects.
- Undertaking public information and education projects.

Appendix I

Suggestions for Further Reading

Less Technical:

Coppock, Raymond, et al., *Using Reclaimed Water on Farmland: Issues and Alternatives.* (Berkeley, CA: University of California Cooperative Extension, 1977), 14 p. [Leaflet 2931 of the Univesity of California Division of Agricultural Sciences] Although focusing on California, this booklet discusses general concerns that farmers and communities might have about treating cropland with wastewater.

Long, David A., *Land Treatment: Citizen Handbook.* (Middletown, Pa: Pennsylvania State University Institute of State and Regional Affairs, 1980), 12 p. This booklet, available through public participation coordinators at the Regional Offices of the U.S. Environmental Protection Agency, provides an excellent introduction to the subject.

Urban Land Institute, *Environmental Comment: Land Application Systems.* (Washington, D.C.: Urban Land Institute, November, 1978), 19 p. Contains excerpts from articles on how land treatment works, the costs of land treatment, and case studies (Muskegon, Michigan and St. Charles, Maryland), as well as selected references.

More Technical:

Knezek, Bernard D., and Robert H. Miller, ed., *Application of Sudges and Wastewaters on Agricultural Land: A Planning and Educational Guide.* (Washington, D.C.: U.S. Environmental Protection Agency, reprinted March, 1978), various pagings. Although some of this book addresses sludge issues, it contains chapters on a variety of issues relevant to wastewater irrigation, including site considerations, crop management, site monitoring and legal concerns.

U.S. Department of Agriculture, Agricultural Research Service, *Factors Involved in Land Application of Agricultural and Municipal Wastes.* (Beltsville, MD: Agricultural Research Service, 1974). 200 p. Chapters on soils and site selection, waste characteristics, crop selection and management, and a variety of other topics.

U.S. Department of Agriculture, U.S. Army Corps of Engineers, and U.S. Environmental Protection Agency, *Process Design Manual for Land Treatment of Municipal Wastewater,* October 1977, various pagings. This is a highly technical manual that covers most of the water quality aspects of land treatment.

Appendix II

Excerpts from the 1977 Clean Water Act

TITLE II—GRANTS FOR CONSTRUCTION OF TREATMENT WORKS

PURPOSE

SEC. 201. (a) It is the purpose of this title to require and to assist the development and implementation of waste treatment management plans and practices which will achieve the goals of this Act.

(b) Waste treatment management plans and practices shall provide for the application of the best practicable waste treatment technology before any discharge into receiving waters, including reclaiming and recycling of water, and confined disposal of pollutants so they will not migrate to cause water or other environmental pollution and shall provide for consideration of advanced waste treatment techniques.

(c) To the extent practicable, waste treatment management shall be on an areawide basis and provide control or treatment of all point and nonpoint sources of pollution, including in place or accumulated pollution sources.

(d) The Administrator shall encourage waste treatment management which results in the construction of revenue producing facilities providing for—

(1) the recycling of potential sewage pollutants through the production of agriculture, silviculture, or aquaculture products, or any combination thereof;

(2) the confined and contained disposal of pollutants not recycled;

(3) the reclamation of wastewater; and

(4) the ultimate disposal of sludge in a manner that will not result in environmental hazards.

(e) The Administrator shall encourage waste treatment management which results in integrating facilities for sewage treatment and recycling with facilities to treat, dispose of, or utilize other industrial and municipal wastes, including but not limited to solid waste and waste heat and thermal discharges. Such integrated facilities shall be designed and operated to produce revenues in excess of capital and operation and maintenance costs and such revenues shall be used by the designated regional management agency to aid in financing other environmental improvement programs.

(f) The Administrator shall encourage waste treatment management which combines "open space" and recreational considerations with such management.

(g)(1) The Administrator is authorized to make grants to any State, municipality, or intermunicipal or interstate agency for the construction of publicly owned treatment works.

(2) The Administrator shall not make grants from funds authorized for any fiscal year beginning after June 30, 1974, to any State, municipality, or intermunicipal or interstate agency for the erection, building, acquisition, alteration, remodeling, improvement, or extension of treatment works unless the grant applicant has satisfactorily demonstrated to the Administrator that—

(A) alternative waste management techniques have been studied and evaluated and the works proposed for grant assistance will provide for the application of the best practicable waste treatment technology over the life of the works consistent with the purposes of this title; and

(B) as appropriate, the works proposed for grant assistance will take into account and allow to the extent practicable the application of technology at a later date which will provide for the reclaiming or recycling of water or otherwise eliminate the discharge of pollutants.

(3) The Administrator shall not approve any grant after July 1, 1973, for treatment works under this section unless the applicant shows to the satisfaction of the Administrator that each sewer collection system discharging into such treatment works is not subject to excessive infiltration.

(4) The Administrator is authorized to make grants to applicants for treatment works grants under this section for such sewer system evaluation studies as may be necessary to carry out the requirements of paragraph (3) of this subsection. Such grants shall be made in accordance with rules and regulations promulgated by the Administrator. Initial rules and regulations shall be promulgated under this paragraph not later than 120 days after the date of enactment of the Federal Water Pollution Control Act Amendments of 1972.

(5) The Administrator shall not make grants from funds authorized for any fiscal year beginning after September 30, 1978, to any State, municipality, or intermunicipal or interstate agency for the erection, building, acquisition, alteration, remodeling, improvement, or extension of treatment works unless the grant applicant has satisfactorily demonstrated to the Administrator that innovative and alternative wastewater treatment processes and techniques which provide for the reclaiming and reuse of water, otherwise eliminate the discharge of pollutants, and utilize recycling techniques, land treatment, new or improved methods of waste treatment management for municipal and industrial waste (discharged into municipal systems) and the confined disposal of pollutants, so that pollutants will not migrate to cause water or other environmental pollution, have been fully studied and evaluated by the applicant taking into account section 201(d) of this Act and taking into account and allowing to the extent practicable the more efficient use of energy and resources.

(6) The Administrator shall not make grants from funds authorized for any fiscal year beginning after September 30, 1978, to any State, municipality, or intermunicipal or interstate agency for the erection, building, acquisition, alteration, remodeling, improvement, or extension of treatment works unless the grant applicant has satisfactorily demonstrated to the Administrator that the applicant has analyzed the potential recreation and open space opportunities in the planning of the proposed treatment works.

(h) A grant may be made under this section to construct a privately owned treatment works serving one or more principal residences or small commercial establishments constructed prior to, and inhabited on the date of enactment of this subsection where the Administrator finds that—

(1) a public body otherwise eligible for a grant under subsection (g) of this section has applied on behalf of a number of such units and certified that public ownership of such works is not feasible;

(2) such public body has entered into an agreement with the Administrator which guarantees that such treatment works will be properly operated and maintained and will comply with all other requirements of section 204 of this Act and includes a system of charges to assure that each recipient of waste treatment services under such a grant will pay its proportionate share of the cost of operation and maintenance (including replacement); and

(3) the total cost and environmental impact of providing waste treatment services to such residences or commercial establishments will be less than the cost of providing a system of collection and central treatment of such wastes.

In the case of any treatment works assisted under this subsection serving commercial users, any such agreement under paragraph (2) shall make provision for the payment to the United States by the commercial users of the treatment works of that portion of the cost of construction of such works which is applicable to the treatment of commercial wastes to the extent attributable to the Federal share of the cost of construction.

(i) The Administrator shall encourage waste treatment management methods, processes, and techniques which will reduce total energy requirements.

(j) The Administrator is authorized to make a grant for any treatment works utilizing processes and techniques meeting the guidelines promulgated under section 304(d)(3) of this Act, if the Administrator determines it is in the public interest and if in the cost effectiveness study made of the construction grant application for the purpose of evaluating alternative treatment works, the life cycle cost of the treatment works for which the grant is to be made does not exceed the life cycle cost of the most effective alternative by more than 15 per centum.

FEDERAL SHARE

SEC. 202. (a)(1) The amount of any grant for treatment works made under this Act from funds authorized for any fiscal year beginning after June 30, 1971, shall be 75 per centum of the cost of construction thereof (as approved by the Administrator). Any grant (other than for reimbursement) made prior to the date of enactment of the Federal Water Pollution Control Act Amendments of 1972 from any funds authorized for any fiscal year beginning after June 30, 1971, shall, upon the request of the applicant, be increased to the applicable percentage under this section.

(2) The amount of any grant made after September 30, 1978, and before October 1, 1981, for any eligible treatment works or significant portion thereof utilizing innovative or alternative wastewater treatment processes and techniques referred to in section 201(g)(5) shall be 85 per centum of the cost of construction thereof. No grant shall be made under this paragraph for construction of a treatment works in any State unless the proportion of the State contribution to the non-Federal share of construction costs for all treatment works in such State receiving a grant under this paragraph is the same as or greater than the proportion of the State contribution (if any) to the non-Federal share of construction costs for all treatment works receiving grants in such State under paragraph (1) of this subsection.

(3) In addition to any grant made pursuant to paragraph (2) of this subsection, the Administrator is authorized to make a grant to fund all of the costs of the modification or replacement of any facilities constructed with a grant made pursuant to paragraph (2) if the Administrator finds that such facilities have not met design performance specifications unless such failure is attributable to negligence on the part of any person and if such failure has significantly increased capital or operating and maintenance expenditures.

(4) For the purposes of this section, the term "eligible treatment works" means those treatment works in each State which meet the requirements of section 201(g)(5) of this Act and which can be fully funded from funds available for such purpose in such State in the fiscal years ending September 30, 1979, September 30, 1980, and September 30, 1981. Such term does not include collector sewers, interceptors, storm or sanitatry sewers or the separation thereof, or major sewer rehabilitation.

Appendix III

Examples of Agreements Between Landowners and Municipalities on Wastewater Irrigation

In areas where wastewater is applied on privated land, an agreement or contract between the community and the landowner is essential. This safeguards the interests of both parties, and allows matters of concern to be addressed at the outset. In the following pages, several examples of actual, working agreements are provided. These are not meant to be a model for other communities to follow: each community's and landowner's situation is unique, and agreement should reflect the fact as best as possible. But it is helpful to know the kinds of concerns that other communities and landowners have raised in their agreements.

The agreements and contracts include:

a. Northglenn, Colorado: An agreement between a county and an irrigation water company.

b. Tuolumne County, California: Agreements among a county water district, individual landowners and the city of Santa Rosa.

c. Dickenson, North Dakota: Agreement between a city and a landowner.

d. Orange County, California: Agreement between a water district and a county.

Northglenn Documents Agreement

THIS AGREEMENT, made and entered into this *2nd* day of September, 1976, by and between The Famers Reservoir and Irrigation Company, hereinafter referred to as FRICO, and the City of Northglenn, a municipal corporation existing under the laws of the State of Colorado, hereinafter referred to as Northglenn, Witnesseth:

WHEREAS the parties recognize that maintenance of existing rural-urban linkages is essential to sustaining a desirable quality of life in both the rural and urban sectors; and

WHEREAS the parties seek to work cooperatively in an effort to strengthen and enhance these rural-urban linkages for their mutual benefit; and

WHEREAS a majority of the shareholders of The Farmers Reservoir and Irrigation Company authorized and approved the concept of a water exchange as set forth in this Agreement by their vote at a special shareholders meeting held on August 24, 2976;

NOW THEREFORE FRICO for and in consideration of the delivery to FRICO by Northglenn of that additional amount of water which totals not less than ten percent (10%) of the water delivered by FRICO to Northglenn as provided herein but not less than 500 acre-feet of water and 15000 acre-feet of storage space furnished FRICO by Northglenn during each of the years in which this Agreement is operative, FRICO, on an exchange of water basis, agrees to supply Northglenn (from Standley Lake operated and controlled by FRICO) sufficient water on an annual basis for the use of Northglenn as hereinafter provided, but, subject however, to all of the terms and provisions set forth herein below:

1. The amount of water to be exchanged annually pursuant to this agreement shall be based upon Northglenn's dry year demand for water in light of existing and projected population figures for the City. For the purpose of illustration, the dry year demand for the present population of approximately 35,000 would require the annual diversion of 6125 acre-feet; a population of 40,000 would require 7148 acre-feet; and the maximum population projected for Northglenn of 48,000 would require the annual diverson of 7785 acre-feet. It is expressly convenanted and agreed, however, that FRICO incurs no obligation to provide water to Northglenn beyond its own physical capacity to do so. Notwithstanding any provision in this paragraph to the contrary, FRICO shall not be obligated to retain any water in Standley Lake for Northglenn beyond that amount of water which Northglenn can immediately replace for use by FRICO stockholders.

2. Northglenn at its sole expense will obtain Water Court approval of its plan which is that following beneficial application of the water delivered to Northglenn by FRICO pursuant to this agreement, Northglenn at its sole expense will collect the water, treat it in accordance with FRICO's specifications, store it and transmit it back to the FRICO irrigation network for delivery to FRICO stockholders.

3. Northglenn, pursuant to direction from FRICO, will return all water exchanged pursuant to this agreement acre-foot per acre-foot to the FRICO system, via transmission facilities to be constructed by Northglenn. Net loss to the water supply occasioned by in-city consumption will be made up by Northglenn from direct flow and underground rights which Northglenn presently owns or will acquire for the express purpose. Northglenn may place water into storage in the Bull Canal storage facility or Northglenn Reservoir Canal during times of a free river to supplement FRICO's supply, but only as approved by FRICO. The Bull Canal storage facility referred to in this paragraph shall be constructed at the sole expense of Northglenn and shall be in operating condition prior to the time when FRICO is required to exchange any water with Northglenn.

4. If, as a result of the multiple use of water which is contemplated by this Agreement, FRICO's priority rights to the use of water are threatened with imminent curtailment by a court or other competent authority, then FRICO shall be released from any obligation to exchange water with Northglenn. At such time as Northglenn has resolved any such problems to the satisfaction of FRICO, the water exchange contemplated herein shall be resumed, in the obligations of the parties under the contract shall be continued.

5. FRICO shall remain free from any obligation to divert water to Northglenn until such time as Northglenn has completed the construction of all necessary and related collection, storage, treatment, and transmission facilities, and has secured a decree from a court of competent jurisdiction for sufficient direct flow, underground, and storage rights to satisfy the obligations which it incurs under this Agreement, and further has secured from the Water Court, Water Division No. 1, approval of this water exchange Agreement. Furthermore, FRICO remains free from any obligations to deliver to Northglenn any water from Standley Lake at any time that Northglenn does not have in storage and available for immediate delivery of FRICO stockholders 500 acre-feet of water.

6. FRICO shall retain operational control over the release of water from Standley Lake. Before making any diversion to Northglenn, FRICO may require that a minimum of 500 acre-feet of water in excess of the amount then being diverted to Northglenn be present storage, it being the intent of this provision to insure to FRICO that at no time will there be a deficit of water in storage.

7. As part of the consideration of this Agreement, any decrees for direct flow, underground, or storage rights presently held by Northglenn or acquired by it in the future, in satisfaction of its obligations uder this Agreement, may be utilized by FRICO for its own needs consistent with the terms of this Agreement.

8. FRICO shall remain free from any obligation to divert water to Northglenn until such time as the total consideration to which FRICO is entitled under this Agreement is existing and capable of immediate implementation by FRICO. Furthermore, FRICO retains the right to discontinue the diversion of water to Northglenn in the event that Northglenn should fail to satisfy its obligations under this Agreement.

9. It is expressly recognized and ur derstood that the Cities of Thornton and Westminster have commenced condemnation actions against FRICO and its stockholders, describing Standley Lake and the water rights which are referred to in this Agreement, which actions are now pending in the District Court in and for Jefferson County, Colorado. Northglenn acknowledges that it makes this Agreement with full knowledge of the limitations and restrictions imposed upon FRICO by such pending condemnation actions.

10. All administrative and legal expenses incurred pursuant to satisfying the terms and conditions of this Agreement shall be borne by Northglenn and in addition, Northglenn agrees to pay within thirty (30) days after billing from FRICO all administrative and legal expenses up to a maximum of $2,000 incurred by FRICO in the negotiation and preparation of this Agreement and related agreements. Northglenn further agrees, if requested in writing by FRICO to do so, to assume the defense of any litigation against FRICO as a consequence of its entering into this Agreement and to bear all costs directly associated with any such litigation holding FRICO harmless for the same. However, in any litigation commenced against FRICO as a consequence of its entering into this Agreement, counsel representing both FRICO and Northglenn shall have the right to participate.

11. At no time, as a result of this Agreement, does Northglenn acquire any appropriative rights to the water provided by FRICO pursuant to this Agreement. It is expressly recognized and understood, however, that in order to effectuate the intent of the parties to this Agreement, the shareholders of the Standley Lake division of FRICO may desire to cause the creation of an interest in their water rights in favor of the City of Northglenn. Any agreement which may be entered into between the shareholders and the City of Northglenn shall be consistent with the terms and conditions of this Agreement and subsequent addendum thereto.

12. It is expressly recognized and understood that this Agreement shall in no way operate or be construed as a conveyance or assignment of any water rights to Northglenn; rather Northglenn agrees to contract with individual FRICO shareholder for the purpose of securing the right to divert and use the water which is contemplated to be exchanged pursuant to this Agreement. During the period in which Northglenn is seeking to obtain the contractual rights to the quantity of water required to satisfy its needs as described in this Agreement, as well as after such contractual rights have been secured, FRICO agrees that is will take all steps necessary to insure the successful implementation of the water exchange system contemplated and described in this Agreement.

13. If by March 2, 1977, Northglenn fails to provide FRICO written evidence of its financial capability to construct or acquire the water supply and all structures necessary to implement this Agreement and the exchange of water contemplated, this Agreement shall automatically terminate and be of no force and effect excepting only as to those obligations of the parties incurred under the terms hereof prior to March 2, 1977, which prior obligations shall remain binding upon the respective parties.

14. Northglenn agrees to commence acquisition and construction of the facilities required to satisfy the terms and provisions hereof by September 2, 1977 and the failure of Northglenn to commence construction of facilities as herein provided shall automatically terminate all of Northglenn's rights and privileges hereunder.

15. The term of this Agreement shall commence on September 2, 1976, and shall be in effect and binding upon the parties for so long as Northglenn shall be in compliance with each of the terms and conditions hereof.

16. If Northglenn requests and agrees to bear all expenses incident thereto, the parties shall immediately begin preparing an addendum to this Agreement setting forth in all necessary detail the structural and operational principles of the proposed water exchange Agreement.

17. If, as a result of FRICO making and entering into this Agreement, any change in FRICO's tax status pursuant to Article X, Section 3, of the Colorado Constitution occurs to FRICO's disadvantage, then Northglenn agrees to assume all FRICO obligations arising directly from the change in its tax status. Provided, however, that should this provision be found to be void as contrary to law or as outside the scope of Northglenn's Home-Rule Authority, the illegality thereof shall not affect any other provision of this Agreement. Provided further that FRICO shall be released from any obligation under this Agreement in the event that Northglenn is prohibited by law from assuming FRICO's tax obligations as contemplated by this provision.

18. The parties will work in cooperation with one another and their respective supportive staffs to insure the design, construction, and operation of a system that will be mutually accommodating and will preserve the intent of the parties as evidenced by this Agreement.

IN WITNESS WHEREOF, the parties have executed the foregoing Agreement in duplicate original counterparts on the day first above written.

Tuolumne Documents Agreement

THIS AGREEMENT made and entered into this day of , 1976, between Tuolumne County Water District No. 2, a county water district, hereinafter sometimes referred to as "Water District", and

hereinafter sometimes referred to as "Landowners".

Witnesseth

WHEREAS, Water District is constructing and will operate the North Tuolumne Basin Wastewater Management Project, a regional sewer system which will make available reclaimed water which, as a result of treatment, will be useable and valuable for irrigation; and

WHEREAS,

own certain real property described in Exhibit A, attached hereto, and shown on the map attached hereto as Exhibit B, consisting of acres more or less, and desire to take delivery of certain quantities of the reclaimed water for irrigation of approximately acres of said lands;

NOW THEREFORE, TUOLUMNE COUNTY WATER DISTRICT NO. 2 and

AGREE AS FOLLOWS:

Section 1. Delivery of Water for Irrigation:

Water District agrees to make available to Landowners, each year during the irrigation season, commencing at the beginning of the 1978 irrigation season, between (200)* and (300)* acre feet of reclaimed water from its North Tuolumne Basin Wastewater Project. Landowners agree to take all of the water made available and use the same that year by irrigation upon the lands described in Exhibit A attached hereto. The irrigation season shall be from about April 15 to about October 15 of each year.

*Sample quantities are given. Generally, the District will quarantee a minimum quantity, but will have the right to deliver, and the landowner must take, up to 1 1/2 times the minimum quantity.

Section 2. Point of Delivery and Distribution:

The water shall be delivered by Water District from its Outfall Pipeline at

and Owners will be responsible for conveying the water from said location to the place of use (including compliance in the conveyance of said water with any applicable laws, regulations, or orders of regulatory agencies having jurisdiction).

Section 3. Price for Water:

Section 4. Rate of Delivery:

The water will be delivered through the irrigation season as nearly as practicable at a rate corresponding to the irrigation requirement curve prevailing in Western Tuolumne County during the irrigation season. The dates and hours and rates of delivery shall be fixed by the Water District after prior consultation with the Landowners, substantially in accordance with the practices of other water or irrigation districts which supply water for irrigation.

Section 5. Controls on Use of Reclaimed Water:

a. Landowners acknowledge that criteria for the use of reclaimed water from the standpoint

of public health have been established pursuant to Section 13521 of the California Water Code, and that persons proposing to use such water (or to make any material change in its use) are required to file a report thereon with the California Regional Water Quality Control Board, Central Valley Region, and to obtain, and to comply with, requirements for such use prescribed by said Regional Board, as provided by Sections 13522.6-13524 of the Water Code.

b. Attached hereto are tentative requirements drafted by the Regional Board Staff for Submittal to the Regional Board for adoption, setting forth the uses that could be made of such water, and controls that would be placed upon such use, in ordinary cases.

c. Landowners agree to file such Report with the Regional Board and to obtain said requirements from the Regional Board, before commencing such use (or making any material change therein), and to comply with such requirements throughout the term of this Agreement.

Section 6. Term of Contract:

Water District agrees to deliver the quantities of water herein specified, and Owners agree to take and use said waters, and this Contract shall remain in full force and effect, for a term of (20/30/40) years.

Section 7. Agreement Runs With The Land:

Landowners agree that their taking of the reclaimed water from the Water District's North Tuolumne Basin Wastewater Management Project (which as used herein shall include the lands and pipeline comprising the Outfall System, the 21.56 acre Treatment Plant property near Sonora described in the conveyance recorded in Volume 424 of Official Records of Tuolumne County, at page 294, the treatment plants near Jamestown and Twain Harte, and all interceptor and collection facilities associated therewith) is of benefit to said Project and to the lands in Sonora, Twain Harte, Jamestown, Columbia, and other communities and areas served by said Project. Landowners further agree that this Agreement and each and every provision thereof is binding upon them and each successive owner of said land described in Exhibit A, and is a covenant, condition and restriction running with said land.

Section 8. Intervention by Other Authority, Etc.:

Water District shall be relieved of delivering the reclaimed water herein specified if effectively prevented from doing so by act of God, or if ordered or enjoined from by doing so by court order or order of any regulatory agency having jurisdiction. Water District may discontinue the delivery of water hereunder and terminate this Contract if Landowners violate any provision hereof.

Section 9. Non-Performance by Landowners:

If for any reason Landowners shall fail to take delivery of the waters herein provided for or to apply them for irrigation as herein provided, Water District shall be entitled to and shall have the right and easement to enter upon said lands, either through its own personnel or by agents or contractors for the purpose, and to apply and discharge said waters to and upon the lands by irrigation in the manner herein contemplated, for the remaining term of this Agreement.

Section 10. Assignability of Contract by Landowners:

The right to receive the water hereunder shall not be assignable by Landowners to other persons (other than upon a conveyance of the land), or transferable to other lands, except upon the prior written consent of Water District.

Section 11. Terms of Regional Board Permits:

Landowners will be released from this Agreement if the Regional Board requirements initially issued to Landowners are substantially more restrictive than those contained in the tentative requirements attached hereto.

Section 12. Temporary Adjustments:

Water District will use its best effort to temporarily reduce the amount of water delivered in any year if Landowners should change their type of crop so as to temporarily require a lesser amount of water than specified in Section 1.

TUOLUMNE COUNTY

TUOLUMNE COUNTY WATER DISTRICT NO. 2

By _____

LANDOWNERS

Tentative Wastewater Reclamation Permit For

(Landowner, Lessee) Tuolumne County

The Regional Water Quality Control Board, Central Valley Region, finds that:

1. (Landowner, Lessee) has filed a report of wastewater reclamation with this regional board pursuant to Section 13522.5 of the California Water Code.

2. (Landowner, Leasee) owns, or controls, agricultural lands indicated in the above report of wastewater reclamation. Such lands comprise acres located

3. The State Department of Health has established statewide reclamation criteria (Title 22, Division 4, Chapter 4, of the California Administrative Code) for the use of reclaimed wastewater.

4. Wastewaters for reclamation uses are to be supplied by the Tuolumne County Water District No. 2 and have been treated to such degree that, under the provisions of Title 22, Division 4, Chapter 4, of the California Administrative Code, they may be used for the following purposes:

a. Irrigation of fodder, fiber and seed crops.
b. Pasture for milking animals
c. Landscape irrigation.
d. Landscape impoundments.

5. The Board has consulted with the Department of Health and received its recommendations.

6. High quality waters exist in both Don Pedro and Tulloch Reservoirs, and a direct discharge of sewage effluent to either of these water bodies could results in degradation of water quality.

7. The Board has notified the user and interested persons of its intent to prescribe wastewater reclamation requirements for the proposed use.

8. The Board in a public meeting heard and considered all comments pertaining to the use of these reclaimed wastewaters.

IT IS HEREBY ORDERED, that (Landowner, Lessee) shall comply with the following:

A. SPECIFICATIONS

1. Reclaimed wastewater may be used for irrigation of pasture, fodder, fiber, or seed crops; and for stockwatering, or esthetic uses where public contact is precluded.

2. Reclaimed wastewater shall not be used for:

(a) Irrigating food crops for human consumption.

(2) Recreational impoundments used for body contact and non-contact activities including, but not limited to, uses for fishing, boating, wading, swimming, and the like.

(c) Irrigation in areas of public access including, but not limited to, uses for lawns, parks, playgrounds, and the like.

3. The direct discharge of wastewater to surface waters or surface water drainage courses is prohibited.

4. Reclaimed wastewaters used for irrigation shall be managed to minimize erosion and runoff.

5. The use of reclaimed wastewater shall not result in a nuisance due to odors, unsightliness, or disease vectors.

6. The landowner or operator must obtain written approval from the Regional Board Executive Officer prior to use of reclaimed wastewater for uses other than those listed in Specification No. 1.

B. PROVISIONS

1. (Landowner, Lessee) shall comply with Reporting Program No. as specified by the Executive Officer.

I, JAMES A. ROBERTSON, Executive Officer, do hereby certify the foregoing is a full, true, and correct copy of an order adopted by the California Regional Water Quality Control Board, Central Valley Region, on _____

JAMES A. ROBERTSON, Executive Officer

Quarterly Reporting Program For (Landowner or Lessee)

Month	Crops	Acreage Irrigated	Water Used (A-F)

I Certify, that to the best of my knowledge, the above is an accurate account of the water used by me on my ranch during the past quarter.

(Signed) _____

Lease Agreement

THIS LEASE AGREEMENT made and entered into this 31st day of May, 1974 between the City of Santa Rosa, a municipal corporation and charter city, hereinafter referred to as "CITY" and WILFRED V. LAFRANCHI, EDWARD A. LAFRANCHI, ARTHUR L. LAFRANCHI, and ESTELLA M. MORETTI, hereinafter referred to as "OWNERS"

Witnesseth

WILFRED V. LAFRANCHI, EDWARD A. LAFRANCHI, ARTHUR L. LAFRANCHI, and ESTELLA M. MORETTI own certain real property described in Exhibit "A" attached hereto, consisting of 275.26 acres more or less.

CITY is the owner and operator of the West College Avenue Wastewater Treatment Plant facility located on the south side of West College Avenue and west of Stony Point Road. The West College Avenue Treatment Plant generates effluent which the CITY must dispose of in sewage treatment process. OWNERS are willing to provide a pondsite of 10.89 acres of real property, more or less, owned by them for the construction of a pond and the storage of sewage effluent as hereinafter set forth in this Agreement.

THE PARTIES HEREBY AGREE AS FOLLOWS:

1. Commencing May 1, 1974, the CITY may use the land described in Exhibit "A" attached hereto for the purpose of constructing a pond suitable for the storage of the sewage effluent as set forth in this Agreement. Commencing May 1, 1975 CITY may use the land described in Exhibit "A" attached hereto for the storage of the sewage effluent from the West College Avenue Treatment Plant of the CITY.

2. It is mutually understood that the entire cost of the construction of the pond and pond supply pipelines, and the continued operation of supplying effluent to the pond and maintenance of said pond and the fence or fences surrounding it, shall be at the sole expense of the City of Santa Rosa. As soon as reasonably possible after construction of the pond, CITY shall also construct a fence surrounding said pond sufficient in size and quality to keep cattle from entering upon said pond or pond area.

3. OWNERS agree that this Agreement is binding as a covenant, condition, and restriction on the land described in Exhibit "A" attached hereto and runs with the land to any subsequent owners.

4. OWNERS agree that the aforesaid land may be used for the construction of a pond and the storage of this sewage effluent as specified herein at a per annum rental of SIX HUNDRED AND NO/100 DOLLARS ($600.00) from the CITY, payable annually in advance on the first day of May of each year. Commencing May 1, 1979, and each year thereafter, the indicated annual rental shall be increased or decreased as a result of negotiations which both of the parties agree to enter into and complete in good faith, said adjustment to be based on any changes in the reasonable value of said property occurring up to that date.

5. This Agreement shall be in full force and effect over the ten and one-half (10 ½) year period from May 1, 1974 through October 5, 1985. At the expiration of this Lease, the pond shall become the property of the OWNERS but the CITY shall not be obligated to provide effluent to this pond beyond the term of this Lease.

6. CITY agrees to deliver to the pondsite described on Exhibit "A" of this Agreement an amount of effluent sufficient to irrigate the OWNERS' lands as per recorded prior agreement between the parties dated , 1974, covering the period from May 1 through October 15 of each year commencing May 1, 1975 through October 15, 1985, unless said delivery is prevented by act of God or by order of a higher governmental authority. The water will be discolored to a dark green color but will not have an offensive odor, and the coliform count and the heavy metals content at point of delivery in the pond shall be at or below the standards set by the North Coast Regional Water Quality Board for the use intended, and in any event not more than the limits set out in the Agreement referred to above.

7. OWNERS do hereby grant permission to the City of Santa Rosa, acting through its duly authorized agents, representatives, or contractors to enter upon the aforesaid property in order to perform all necessary labor and installation of equipment and pipelines required by this Lease Agreement and to maintain and operate the system.

8. OWNERS shall not be liable for any loss, damage, or injury of any kind or character to any person or property arising from any use of the pondsite, or any part thereof, or caused by any defect in any structure or other improvement thereon or in any equipment or other facility therein, or caused by or arising from any act or omission of CITY, or of any of its agents, employees, licensees, or invitees, or occasioned by the failure of CITY to maintain the pondsite in safe condition, or arising from any other cause whatsoever, and CITY hereby agrees to indemnify and hold OWNERS entirely free and harmless from all liability for any such loss, damage, or injury of other persons, and from all costs and expenses arising therefrom.

9. The execution of the Agreement referred to in Paragraph 6 above is a condition precedent to the validity and effectiveness of this Agreement.

IN WITNESS WHEREOF, the parties hereto have set their hands and seal on the day and year set forth above.

OWNERS

BY _____
Arthur L. Lafranchi

Wilfred V. Lafranchi

Edward A. Lafranchi

Estella M. Moretti

CITY OF SANTA ROSA,
A Municipal Corporation

BY _____
Mayor

Exhibit "A"

Being a portion of that parcel of land, LaFranchi Land Co. to LaFranchi et al as recorded February 19, 1968 in Official Records of Sonoma County, Book 2315, Page 499, said parcel being more particularly described as follows:

Commencing at a point on the Northerly line of Guerneville Road at the Southwesterly corner of that certain 19.19 acre tract particularly described in the deed made by J.C. Nathanson, et al to Jose S. Azevedo, dated November 2, 1928 and recorded in Book 212, Page 259 Sonoma County Records; thence Westerly along the Northerly line of Guerneville Road 646 feet more or less to the point of beginning; thence North 460 feet; thence West 145 feet; thence N 7°32'32" E 373 feet; thence N 89°53'12" W 417 feet; thence S 69°02'32" W 315 81 feet; thence South 711 feet; thence S 89°15'56" E 518 feet to the point of beginning and containing 10.9 acres more or less.

Ref: R-966

COPY

STATE OF CALIFORNIA]
]
COUNTY OF SONOMA]

On May 31, 1974, before me, the undersigned, a Notary public whose principal place of business is in the County of Sonoma, State of California, personally appeared ARTHUR L. LAFRANCHI, WILDFRED V. LAFRANCHI, and ESTELLA M. MORETTI, known to me to be the persons named in the within instrument, and whose names are subscribed thereto, and acknowledged to me that they executed the same.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year in this certificate first above written.

OFFICIAL SEAL

Teresa Matott
signed
Notary Public in and for the County of Sonoma, State of California.
My Commission Expires:

STATE OF CALIFORNIA]
] ss
COUNTY OF ALAMEDA]

On , 1974, before me, the undersigned, a Notary Public whose principal place of business is in the County of Alameda, Sate of California, personally appeared EDWARD A. LAFRANCHI, known to me to the the

City of Dickenson, North Dakota

Agreement

THIS AGREEMENT, Made and entered into this day of January, 1972, by and between the City of , a municipal corporation, organized and existing under the laws of the State of North Dakota, hereinafter referred to as the "CITY" and North Dakota, hereinafter referred to as "

WITNESSETH:

WHEREAS, The City has for the past few years and continues to be in need of a means of draining water from the City sewer lagoon so that the lagoon will effectively perform its function; and

WHEREAS, the City is restricted in the draining of such water discharge into the Heart River, and therefore must spread such water on the adjoining land, at least until adequate sewage treatment facilities can be built; and

WHEREAS, the City and on September 15, 1969, entered into a written Lease Agreement whereby an 18.07 acre parcel of land owned by the City was leased to and pursuant to such Lease, has leveled and developed said land for irrigation purposes, so as to utilize water discharge from the City sewer lagoon which adjoins said leased premises; and

WHEREAS, since that time the City has contributed power, labor, and equipment and has contributed labor and equipment in a cooperative effort to spread water discharge from the sewer lagoon upon the leased premises and also upon land adjoining the sewer lagoon owned by ; and

WHEREAS, the City desires to enter into an agreement which will insure that it will be able to continue to drain such water discharge from the sewer lagoon onto the adjoining land, as required for the effective operation of said sewer lagoon until adequate sewage treatment facilities can be constructed by the City; and both parties desire to specify the terms and conditions of such arrangement;

NOW THEREFORE, it is hereby agreed as follows:

1. **Term.** This agreement shall be effective until such time as the City has completed construction of adequate sewage treatment facilities and such facilities have become operational to a point where it alleviates the need for the City to spread water from the existing sewer lagoon cells, pursuant to this Agreement; provided, however, that in any event this Agreement shall terminate in five (5) years if not sooner terminated as referred to above.

2. **Spreading of Lagoon Water.** agrees that the City may continue to discharge water from the sewer lagoon and spread it upon his land by means of suitable irrigation methods and procedures, utilizing the irrigation equipment now owned by as well as any mainline pipe or other equipment owned by the City, with the City to furnish all energy costs for the pumping of said water, whether the irrigation is done by the City or by Whenever the City desires to irrigate in order to drain such water it shall furnish all labor required for such purpose and it will be responsible for any damages occasioned by its negligence. agrees that the City can irrigate at any time, subject to reasonable control by him over the timing, place and quantity of water discharged as is required for good farming purposes. In addition to the irrigation done by the City, it is agreed that can irrigate at any time utilizing such water discharge, subject to approval of the water superintendent, but in such event he shall furnish his own labor. It is further agreed that in the event the water discharge becomes harmful to the grass or land, will have the right to dilute it utilizing water from the Heart River for such purpose.

3. **Binding Effect.** This Agreement shall be binding upon the respective parties hereto, their successors and assigns.

IN WITNESS WHEREOF, the parties hereto have set their hands and seal the day and year first above written.

THE CITY OF DICKINSON, NORTH DAKOTA
A Municipal Corporation

By /s/ Henry Schank
Henry Schank, President
Board of City Commissioners

ATTEST:

/s/ James K. Gerou

James K. Gerou, City Auditor

STATE OF NORTH DAKOTA]
] ss
COUNTY OF STARK]

On this 6 day of January, 1972, before me, a Notary Public in and for Stark County and State of North Dakota, personally appeared Henry Schank and James K. Gerou, to me known to be the President of Board of City Commissioners and City Auditor, respectively, of the corporation that is described in and that executed the foregoing instrument, and acknowledged to me that such corporation executed the same.

, Notary Public
Stark County, North Dakota
My Commission Expires: 6/21/74
/s/

STATE OF NORTH DAKOTA
COUNTY OF STARK ss

On this day of January, 1972, before me, a Notary Public in and for Stark County and State of North Dakota, personally appeared.

Sewage Effluent Agreement

THIS AGREEMENT made and entered into this 24th day of March, 1954 and as amended the 28th day of April, 1954, by and between COUNTY SANITATION DISTRICTS OF ORANGE COUNTY, CALIFORNIA, numbered 1, 2, 3, 5, 6, 7 and 11 respectively, hereinafter for convenience referred to as "Supplier," and , hereinafter for convenience referred to as "User";

Witnesseth

THAT WHEREAS represent the owners or users of approximately 2,000 acres of land in the Talbert Valley area of Orange County; and

WHEREAS, there is presently in process of organization in said 2,000 acre area a special assessment district of some form for the purpose of raising sufficient funds to construct necessary facilities for the use of sewage effluent upon said lands; and

WHEREAS, such district will not be legally formed for some time in the future and it would aid and assist such formation to have this agreement providing the terms and conditions upon which users may purchase sewage effluent; and

WHEREAS, supplier is willing and anxious to cooperate with users and will assist in making available such partially treated sewage water and industrial wastes as users may desire to use in the interest of water conservation; and

WHEREAS, it is believed that there is at present partially treated sewage water and industrial wastes suitable for user's purposes, and that such water is in sufficient quantities to meet user's requirements; and

WHEREAS, by reason of the urgency of the water supply situation, , as trustees, have agreed to enter into this agreement with supplier, in trust for the owners and users of said land and to be assigned entirely to the district formed to provide facilities for delivering sewage effluent from supplier's facilities.

NOW, THEREFORE, in order to carry out the foregoing intentions and purposes, it is mutually agreed between the parties hereto follows:

(1) Supplier agrees to make available to user at a point or points on the ocean discharge line from seller's treatment plants, sewage effluent from said plants. Any connections to said ocean discharge line or other facilities attached thereto or a part thereof and necessary to make such sewage effluent available shall be installed by user at their expense under the supervision of supplier.

(2) User agrees to pay to supplier for such sewage effluent taken by them the sum of 50¢ per acre foot. User shall provide the measurement of such quantities and shall pay for same within thirty days after the close of each calendar month in which sewage effluent is used. Said price shall be subject to revision by seller at the end of each five year period to cover administrative costs to supplier in relation thereto or in the event such effluent develops a market value, provided, however, that in no event shall the price paid by User to Supplier for such sewage effluent exceed the sum of two dollars and fifty cents ($2.50) per acre foot during the twenty year term of this Agreement, said price shall be negotiated to reflect the then market value.

Appendix B

Copy of Resolutation 55-12 Adopted September 23, 1955, by Regional Water Pollution Control Board No. 8 Concerning the Talbert Water District

WHEREAS, the Talbert Water District, whose mailing address is 401 West Eighth Street, Santa Ana, California, on May 13, 1955 filed an application with the Director of Water Pollution Control, County of Orange, for a permit to dispose of sewage and industrial waste by means of irrigation of lands within the said District in the Talbert area of Orange County, subject to the provisions of Ordinance No. 703 of the County of Orange, and

WHEREAS, this Board, under the provisions of a cooperative procedure adopted jointly with the County of Orange, considers the aforesaid application to be a report of waste discharge as required by Division 7, Water Code, State of California, and

WHEREAS, in June 1952 the State Engineer submitted a report to this Board entitled "Effects of Excess Sewage Disposal from Orange County Joint Outfall Sewer," said report presenting findings of an investigation into the geology, hydrology and water quality of the general area proposed for sewage and industrial waste disposal in the aforesaid application, and

WHEREAS, other reports and documents are on file at the Office of this Board presenting data relative to the geology, hydrology and water quality of the aforesaid area and to the quality of the aforesaid sewage and industrial waste, and

WHEREAS, the project proposed by the aforesaid application represents a culmination of several years' effort to provide a usable water supply for agricultural lands in an area the quality of whose underlying ground water supply has been destroyed or is threatened with destruction by the invasion of ocean water, and

WHEREAS, on June 22, 1955 this Board reviewed the aforesaid application and in view of the importance of the proposed project for reclamation of sewage and industrial waste to the economy of the lands within said District, stated that it had no objection to the project, subject to conditions to be agreed upon by the Director of Water Pollution Control, County of Orange, and representatives of other interested State and Orange County agencies, and

WHEREAS, field investigations have been conducted by the staff of this Board and numerous consultations have been held concerning the aforesaid application between representatives of the Talbert Water District and the staffs of the Director of Water Control, County of Orange, the Orange County Health Department, the State Department of Public Health, and State Division of Water Resources, and this Board, and

WHEREAS, based on the foregoing this Board finds that: (1) The proposed disposal of sewage and industrial waste will be on lands west of the Santa Ana River, south of Garfield Avenue and east of Huntington Beach Boulevard in the coastal portion of Orange County, such lands being within the boundaries of the Talbert Water District and comprising approximately 2250 acres of irrigable lands, the exact location of which is set forth in a map of the said District on file with this Board. (2) The proposed disposal area is underlain by deposits of Recent alluvium and San Pedro formation. The Recent alluvium contains two water-bearing aquifers, an upper semi-perched zone and a lower Talbert zone.

Appendix C

Copy of Industrial Waste Permit No. 42 Issued August 17, 1955, by Orange County Water Pollution Ordinance No. 703 Concerning the Talbert Water District

Pursuant to Ordinance No. 703 of the County of Orange and all articles and sections hereunder, an application has been received and processed as required by said Ordinance. Therefore a permit is hereby granted to Talbert Water District whose mailing address is 401 West Eighth Street, Santa Ana and whose street address is
to dispose of industrial waste subject to provisions following within the unincorporated areas of the County of Orange as follows: said industrial waste shall be limited to sewage effluent from County Sanitation District Plant #1 and point of discharge shall be at the eastern end of Yorktown Street in Talbert Valley Lands.

All reports, letters and data pertaining hereto not shown on the face of this permit shall be considered a part of this permit as if they were inscribed hereon. This permit is granted subject to the following provisions:

1. This permit does not authorize any act or acts forbidden by any law, rules, regulations or orders of any public agency or county department.

2. The provisions of this permit may be changed, deleted or added to in accordance with Section 403, Sub-paragraph (h) and Section 104.

3. All "Regulations Relating to Cross-Connections" and "Regulations on Use of Sewage for Irrigating Crops" of the State Department of Public Health shall be carried out.

4. The pipe or pipes shall be of such materials as are approved by the State Department of Public Health.

5. The reservoir shall be constructed in such a manner as to be readily emptied and cleaned.

6. The following materials shall not be in excess of the amounts indicated:

a.	Boron	1.00 ppm
b.	Phenol	0.10 ppm
c.	Hexavalent chromium	0.10 ppm
d.	Fluorides	2.00 ppm
e.	Chlorides	225.00 ppm
f.	Bicarbonate	400.00 ppm
g.	Sulphates	300.00 ppm
h.	Soluble sodium shall not exceed 60% or	420.00 ppm

8. Instrumentation shall be provided so that the total dissolved solids shall not at any time exceed 1200 ppm average from the outflow of the reservoir. The electrical conductivity (EC X 10^6 @ 25°C) *shall not be greater than 1800.*

☆U.S. GOVERNMENT PRINTING OFFICE: 1981—777-000/1109